

publisher.agency
Ireland

December, 2025

No 11



Dublin, Ireland
4-5.12.2025

International
Scientific
Conference

Interdisciplinary Science Studies

UDC 001.1

P 97

Publisher.agency: Proceedings of the 11th International Scientific Conference «Interdisciplinary Science Studies» (December 4-5, 2025). Dublin, Ireland, 2025. 547p



ISBN 978-0-6155-8900-8

DOI 10.5281/zenodo.17853967

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АДАМ ФИЗИОЛОГИЯСЫ ЖӘНЕ ДЕНСАУЛЫҚ МӘДЕНИЕТІ (9-СЫНЫП) (АВТОРЛЫҚ БАҒДАРЛАМАНЫ ТӘЖІРИБЕДЕ ҚОЛДАНУ ЖӘНЕ ЗЕРТТЕУ НӘТИЖЕЛЕРІ) 510

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Speech development in inclusive classrooms

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Keys words: *Inclusive education, speech development, teaching methods, communication skills, social communication*

The philosophy of inclusive education ensures the right and opportunity for all children, including those with special educational needs, to study together with their peers in the same classroom environment. All children, regardless of race, religion, gender, health conditions, or social background, are included in this concept. The main goal of inclusive education is to maximize each learner's potential, eliminate discrimination, and fully integrate them into society.

The modern education system, based on an inclusive approach, aims to provide equal learning opportunities for children with different developmental levels, learning difficulties, speech disorders, and psychological characteristics. In this context, work on speech development not only improves language skills but also contributes to socialization, cooperation, emotional expression, and the formation of communicative culture. The development of speech skills in an inclusive classroom is considered one of the key indicators of the quality of instruction, as children acquire knowledge, express their ideas, and communicate effectively with peers through speech. Therefore, the systematic and purposeful organization of speech development work should be at the center of the educational process in inclusive settings.

Speech development in an inclusive classroom is based on instruction tailored to the individual needs of each student. This process should begin with an initial diagnostic assessment of the learners' speech abilities to determine their individual needs. Since speech difficulties can vary significantly from one child to another, a personalized approach must be selected accordingly. Developing an Individual Education Plan (IEP) is crucial in determining appropriate methods. First, the factor hindering speech development must be accurately identified. These factors may include hearing impairment, intellectual disabilities, communication disorders, or language deficits. Once the cause is identified, the methods that will positively impact the learner's speech development should be defined. The IEP should also clearly outline the learner's speech level, comprehension and attention skills, speech rate, expressive range, and social communication abilities. Additionally, the plan must include clear, achievable, result-oriented goals adapted to the learner's developmental stage.

Differentiated instruction, which is a core element of inclusive education, involves presenting the same material at varying levels of difficulty. Differentiation is also essential when working on speech development. At this stage, adaptation—which involves concrete, classroom-level modifications—may include simplified texts, smaller tasks, clear and concise verbal instructions, and audiovisual support. These measures help children with speech difficulties experience success and maintain motivation.

Developed speech is closely connected with the development of thinking. Speech directly influences thinking, and thinking also contributes to the improvement of speech. Thus, the development of speech and thinking is an interdependent, long-term process. For this process to

succeed, learners must gradually acquire attention, listening, comprehension, imitation, and participation skills, as deficits in any of these areas hinder effective speech development.

A learner expresses thoughts to others through speech. Mastering proper language use and rules is one of the fundamental requirements in inclusive classrooms. Active learning methods and interactive lessons foster the development of speech skills. Alongside speech development, students further improve facial expressions, gestures, and correct posture. Work with figurative expressions and vocabulary enhances creative thinking. High-quality speech exercises and well-prepared materials are essential to ensure meaningful speech. Furthermore, learners must be provided with an environment in which they can use all necessary speech tools to express themselves freely. As students develop oral skills, they begin to form figurative speech, adapt their speech to new situations, construct expressive sentences, search for new words and expressions, and develop logical sequencing of ideas. A learner's mental development depends on speech development. Through speech, attention, memory, willpower, and perseverance develop. Expressing ideas orally and in writing enhances cognitive skills and allows learners to communicate thoughts logically and coherently.

Speech development in inclusive classrooms is a key factor in a learner's psychological and social development. Speech not only enhances thinking, memory, attention, and self-control but also supports socialization, cooperation, and communication.

In conclusion, speech development in inclusive classrooms is not merely about forming language skills; it also ensures learners' psychological, social, and creative growth. The methodological competence and purposeful work of teachers play a decisive role in ensuring the effectiveness of this process.

THE FUTURE OF EDUCATION: HOW AI IS TRANSFORMING UNIVERSITY LEARNING

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ABSTRACT

This study examines the role of artificial intelligence (AI) in transforming university learning, focusing on how AI tools support comprehension, writing, reading, and motivation. With AI becoming increasingly common in higher education, it is important to understand how students use these tools and what benefits or challenges arise. A quantitative survey was conducted among 19 university students to explore their usage patterns, perceptions of AI effectiveness, and difficulties faced during learning. The findings show that AI is widely integrated into students' academic routines, particularly for language learning, understanding complex topics, and writing support. While AI improves comprehension and engagement, challenges such as information overload, technical issues, and difficulty interpreting AI responses remain. The study highlights the importance of guided AI use, digital literacy training, and personalized recommendations to maximize learning outcomes. Overall, the research suggests that AI offers significant potential for enhancing university learning, but its effectiveness depends on careful integration, support, and strategies to overcome common obstacles.

KEYWORDS: Artificial Intelligence, Higher Education, Learning Support, Writing Skills, Reading Skills

INTRODUCTION

Artificial intelligence (AI) is increasingly shaping higher education, with its use in learning activities gaining significant attention. AI tools offer personalized support, simplify complex topics, and provide students with instant feedback, transforming traditional learning approaches (Baker & Inventado, 2014). In university settings, AI can support a wide range of academic tasks, including language learning, writing, and reading, allowing students to access explanations and practice exercises independently (Gonzalez et al., 2023). However, integrating AI into learning also raises challenges, such as information overload, technical difficulties, and the need for proper guidance (Ivanova, 2020).

Among AI tools, chatbots like ChatGPT and AI-based language-learning applications have emerged as prominent resources. ChatGPT, developed by OpenAI, uses advanced natural language processing to provide coherent, context-aware responses to users' questions, enabling interactive and adaptive learning experiences (Vaswani et al., 2017). Unlike traditional learning methods, ChatGPT can provide immediate feedback, explanations, and language support, making it especially useful for tasks like writing assistance and understanding complex concepts (Almarzooq et al., 2023). Similarly, AI language-learning apps such as Duolingo allow students to practice vocabulary, reading, and listening skills independently, reinforcing classroom instruction.

The frequent use of AI in students' academic routines suggests that these tools are becoming an integral part of learning processes. Many students report relying on AI for

explanations, homework support, and language practice, which highlights the growing dependence on technology to supplement traditional teaching methods (Bekova, 2021). Additionally, AI provides flexibility, allowing learners to study at their own pace, review content multiple times, and engage with material outside of classroom hours (Cheng et al., 2021). This flexibility is particularly valuable in higher education, where students must manage complex coursework and develop self-directed learning strategies.

Despite its benefits, AI-assisted learning is not without limitations. Students often face challenges such as receiving too much information, encountering technical issues, or struggling to interpret AI-generated content correctly (Akhmetova, 2022). These difficulties can reduce the effectiveness of AI tools if proper guidance and structured integration are not provided. Educators play a key role in mediating these challenges by offering support, recommending best practices, and integrating AI into the curriculum in a balanced and purposeful manner (Florian, 2014).

The primary objectives of this study are to examine how AI tools, particularly chatbots and language-learning applications, support university students in comprehension, writing, reading, and motivation; to assess the perceived effectiveness of AI in daily academic routines; to identify common challenges faced by students; and to explore strategies for optimizing AI-assisted learning in higher education.

Research questions:

1. How do AI tools support comprehension, writing, reading, and motivation in university students' learning?
2. What are the main challenges students face when using AI tools, and how can these be addressed effectively?
3. How can AI be integrated into higher education to maximize its benefits while minimizing potential limitations?

METHODS

This study employed a quantitative research design to examine how university students use artificial intelligence in their daily learning and how they perceive its effectiveness in higher education. In order to identify the frequency of AI use, determine which tools students rely on most, and explore the challenges learners face when integrating AI into academic tasks, data were collected through a structured questionnaire and analyzed using descriptive statistics to reveal general tendencies and patterns.

The study involved 19 university students from different academic years and programs. All participants regularly engage in university coursework and have varying levels of experience with AI tools. Their age ranged from 17 to 24, representing a typical undergraduate learner population. Since AI has recently become widely used among students, all participants reported having at least some prior exposure to digital learning technologies.

The primary research instrument was an online Google Forms questionnaire consisting of 16 closed-ended items. The questionnaire included multiple-choice, Likert-scale, and frequency-based questions grouped into several sections: frequency of AI use, preferred AI tools, perceived effectiveness of AI for understanding lessons, impact on motivation, skills improved with AI, challenges encountered.

These item categories were selected specifically to align with the study's aim of understanding how AI influences university learning experiences. The form was shared through university student groups on social media platforms.

The research started with reading previous studies about AI in higher education to understand what factors are important for student opinions and how they use AI tools. Using this information, a clear and simple questionnaire was created. After making final corrections, the

survey was shared with participants, and they were informed that their answers were confidential and voluntary.

After collecting all responses, the data were examined using basic statistics provided by Google Forms. The analysis looked at percentages, frequency counts, and the most common trends across the six criteria. This helped the researcher clearly see how students use AI in their daily studies and which areas of AI-based learning still need more improvement.

RESULT

Demographic and General Information

This survey, completed by 19 university students, offers an overview of their general use of AI in academic contexts. The responses show how often students rely on AI tools, which types of support they use most, and how helpful they consider these tools in their learning process. The results indicate that AI has already become a regular part of students' study routines, especially for language learning, understanding complex topics, and receiving writing assistance. At the same time, the data highlight several difficulties students still encounter, including information overload and occasional technical problems.

Frequency of AI Use During Learning

Regarding the frequency of AI use during learning, 42.1% of students reported using AI often, 31.6% stated that they use it very often, and 26.3% indicated that they use it sometimes (Figure 1). Notably, no participants selected "rarely" or "never." These results show that more than 73% of students rely on AI tools on a daily or weekly basis, demonstrating a strong integration of AI into their study habits. This suggests that AI has become an essential part of their learning routines, particularly for explanations, homework assistance, and language-related tasks.

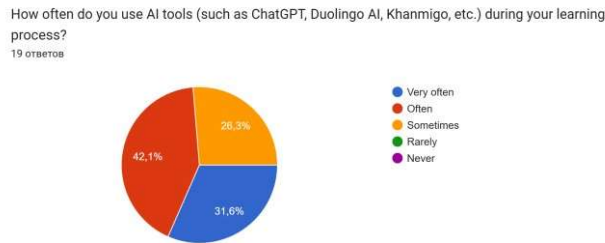


Figure 1

Frequency of AI tools	Percent %
Very often	31.6%
Often	42.1%
Sometimes	26.3%
Rarely	0%
Never	0%

Table 1

Most Frequently Used AI Tools

When identifying which AI tools students rely on most, AI chatbots such as ChatGPT or Bard were selected by 73.7% of participants, while the same percentage (73.7%) reported using AI language-learning apps like Duolingo (Figure 2). AI video or explanation tools were used by 26.3% of students, and 21.1% preferred AI summarizing or note-taking tools. A smaller group, 10.5%, stated that they do not use any AI tools at all. These results show that chatbots and language-learning applications dominate students' AI usage, suggesting that features such as instant

feedback, clear explanations, and accessible practice activities are the most valued aspects of AI-assisted learning.

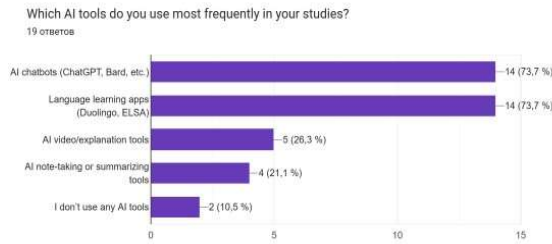


Figure 2

Most Frequently Used AI Tools	Percent %
AI chatbots (ChatGPT, Bard, etc.)	73.7%
Language learning apps (Duolingo, ELSA)	73.7%
AI video/explanation tools	10.5%
AI note-taking or summarizing tools	21.1%
I don't use any AI tools	10.5%

Table 2

Effectiveness of AI in Understanding Lessons

Students' perceptions of AI's effectiveness in supporting lesson comprehension varied. A total of 52.6% agreed that AI helps them understand lessons better, while 26.3% strongly agreed (Figure 3). Meanwhile, 10.5% remained neutral and another 10.5% disagreed, with no students strongly disagreeing. Overall, nearly 79% of participants found AI to be effective or highly effective, indicating that AI contributes to improved comprehension by providing clear explanations, illustrative examples, and immediate clarification during learning activities.

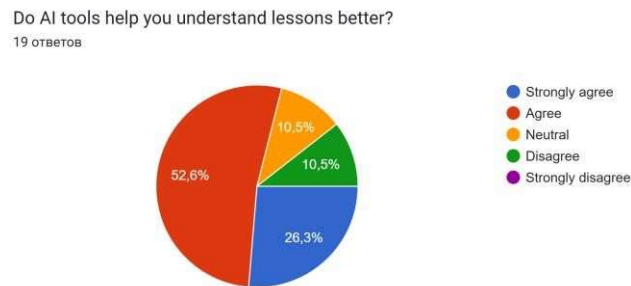


Figure 3

Helpfulness	Percent %
Strongly agree	26.3%
Agree	52.6%
Neutral	10.5%
Disagree	10.5%
Strongly disagree	0%

Table 3

Impact of AI on Motivation and Interest

When asked about AI's impact on motivation and interest in learning, 52.6% of students agreed that it makes learning more engaging, while 10.5% strongly agreed (Figure 4). Meanwhile, 31.6% were neutral, and 5.3% strongly disagreed. These findings suggest that AI can enhance motivation, particularly through interactive features and personalized feedback, although some students' engagement still depends on teaching methods and individual learning preferences.

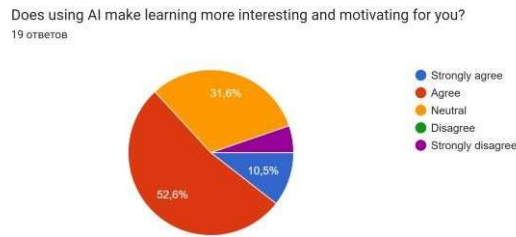


Figure 4

Skills Improved the Most Thanks to AI

When evaluating which skills improved the most through AI use, 42.1% of students reported improvements in writing, 21.1% in reading comprehension, 21.1% in speaking and pronunciation, and 15.8% in vocabulary (Figure 5). No students selected problem-solving or “none.” These results indicate that AI tools are particularly effective for writing and reading tasks, likely due to the detailed feedback, corrections, and explanations provided by chatbots and language-learning apps, while improvements in speaking skills are less pronounced.

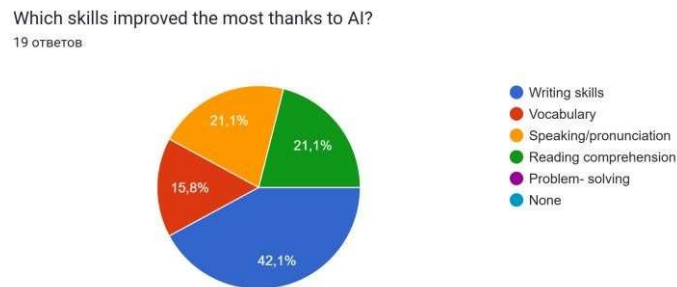


Figure 5

Challenges Faced When Using AI

Students reported several challenges when using AI: 36.8% experienced information overload, 21.1% faced internet or device issues, 15.8% had difficulty understanding AI instructions, 10.5% felt AI was not always accurate, and 15.8% reported no challenges (Figure 6). The most frequent issue was receiving too much information, which can make learning confusing, while technical problems also posed a notable barrier to effective AI use.

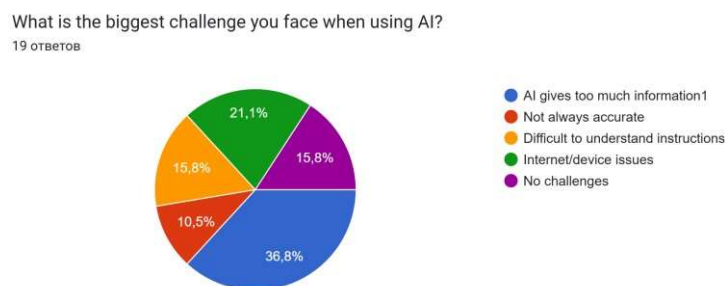


Figure 6

No	Criterion	Key Findings	Interpretation
1	Frequency of AI Use	31.6% very often, 42.1% often	AI is widely integrated into daily student routines.
2	Preferred AI Tools	73.7% chatbots & language apps	Students rely most on tools offering instant feedback.
3	AI Effectiveness	78.9% positive responses	AI significantly supports lesson comprehension
4	Motivation	63.1% positive	AI increases interest but not for everyone
5	Skills Improved	Writing (42.1%) top skill	AI helps most with text-based academic tasks.
6	Challenges	Info overload (36.8%) main issue	Students need guidance to use AI more effectively.

Table 4

Overall, the results of this study demonstrate that AI has become an integral part of university students' learning routines, particularly for understanding complex topics, improving language skills, and supporting writing tasks. Students generally perceive AI as effective in enhancing comprehension and motivation, though challenges such as information overload and technical issues remain. These findings suggest that while AI offers significant benefits for higher education, structured guidance and support are essential to maximize its positive impact on student learning.

DISCUSSION

The results of this study provide valuable insights into how university students use AI tools in their academic routines and the challenges they face. The findings highlight the importance of AI in supporting learning, especially for understanding complex topics, improving writing, and practicing languages. At the same time, students encounter difficulties such as information overload and technical issues, which can limit the effective use of AI. These findings align with previous studies emphasizing the role of AI in enhancing learning outcomes, engagement, and skill development (Baker & Inventado, 2014; Ivanova, 2020; Bekova, 2021).

Regarding the frequency of AI use, over 73% of students reported using AI often or very often, indicating that AI has become an integral part of their study routines. This suggests that students rely on AI tools not only for quick explanations but also for completing homework and practicing language tasks. These results reflect prior research that highlights the growing integration of AI in higher education (Akhmetova, 2022).

In terms of the types of AI tools used, 74% of students preferred chatbots like ChatGPT and language-learning apps such as Duolingo. Other tools, including video explanations and note-taking apps, were less frequently used. This emphasizes that students value instant feedback, clear explanations, and interactive learning activities. However, challenges such as information overload (37%) and technical issues (21%) show that guidance and structured use are needed to maximize AI's benefits (Bekova, 2021).

Students reported that AI effectively supported lesson comprehension, with 79% indicating improved understanding. This aligns with research showing that AI can clarify complex content, provide examples, and offer immediate support, although some students may still struggle with more complicated material (Gonzalez et al., 2023).

Regarding motivation, 63% of students stated that AI made learning more engaging, while a smaller group remained neutral or disagreed. These findings suggest that AI can enhance motivation, particularly through interactive features and personalized feedback, but learning engagement still depends on individual learning preferences and instructional design (Baker & Inventado, 2014).

Finally, the main challenges identified include information overload (37%), internet or device problems (21%), difficulty understanding AI instructions (16%), and occasional inaccuracies (10%). Addressing these challenges requires guidance on effective AI use, training to build digital literacy, and careful selection of AI tools to suit learning goals (Akhmetova, 2022; Bekova, 2021).

Overall, this study shows that AI can be a helpful tool for learning. It can improve understanding, writing, reading, and make studying more interesting. However, its benefits depend on using AI in a planned way, with guidance and support to avoid problems like too much information or technical issues. To help students get the most from AI, schools and teachers can provide training on how to use AI tools, suggest apps or chatbots that fit students' needs, and guide them during practice. Addressing these challenges—such as information overload, device problems, and difficulty understanding AI instructions—will make AI use more effective and support better learning outcomes.

CONCLUSION

In conclusion, this study highlights the significant role of AI tools, such as ChatGPT and language-learning applications, in supporting university students' learning processes, particularly in comprehension, writing, reading, and motivation. The findings show that students who frequently use AI tools benefit from instant feedback, clear explanations, and accessible practice activities, which enhance their understanding and engagement in academic tasks. AI has thus become an important supplement to traditional learning methods, providing flexible and personalized learning opportunities.

However, the study also identifies challenges that may limit the effectiveness of AI, including information overload, technical issues, and occasional difficulties in understanding AI-generated content. These limitations suggest that AI alone cannot replace structured guidance or human-led instruction. Integrating AI with educator support, clear usage strategies, and targeted training can help students overcome these challenges and maximize the benefits of AI-assisted learning.

Moving forward, combining AI tools with traditional teaching approaches offers a balanced and effective method for higher education. Future research should focus on refining AI tools to enhance their reliability, user-friendliness, and adaptability to individual learning needs, ensuring that students can fully leverage AI for academic success.

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İNGİLİS DİLİNİN TƏDRİSİNİN TƏTBİQİ TENDENSIYA

Əfsanə Rüstəm qızı Bəşirzadə

Azərbaycan Dövlət Pedaqoji Universitetinin Şəki filialı, müəllim

XÜLASƏ

Müəllim peşəkarlığının artırılmasında və inkişafında qabaqcıl təcrübənin təhlil olunması, öyrənilməsi ilə yanaşı, şəxsi təcrübənin də yayılması əsas amildir. Belə ki, müəllim məqalələr hazırlayıb, nəşr etdirməli, müasir informasiyokommunikasiya texnologiyalarından istifadə etməklə, internet resursları vasitəsilə peşə saytı və proqramları yaradaraq şəxsi təcrübəsini bölüşməlidir. Bunu reallaşdırmaq üçün təhsilverənlərə əlverişli şərait yaradılmalı, məsələn, distant və ya ənənəvi kurslar, təlimlər, konfranslar, seminarlar, müzakirələr, müsabiqələr, olimpiadalar, layihələr, treninqlər təşkil edilməlidir. Belə tədbirlərdə müəllimlərin iştirakı peşəkarlığın artırılmasına xidmət edir. Müasir təhsilə yeni yanaşmalar tədris materiallarının, proqramlarının, metodlarının, yanaşmalarının, texnologiyaların modernləşdirilməsi ənənəvi "peşəkarlığın" da dəyişməsinə, müasir tələblərə cavab verməsinə tələb edir. Bunun üçün isə hər bir müəllimə özünü inkişaf etdirmək üçün şərait yaradılmalı və dəstək olunmalıdır.(1,45)

Dünyada baş verən davamlı dəyişikliklər fonunda ölkəmizin təhsil sektoru da dövrün tələblərinə uyğun olaraq inkişaf edir. Bu proses ingilis dilinin tədrisinin müasir dövrün tələblərinə uyğunlaşdırılmasını zəruri edir. Aydın ki, dərslərin XXI əsrin tələblərinə uyğun təşkilində, şagirdlərdə tənqidi düşüncə, yaradıcılıq, əməkdaşlıq, ünsiyyət, özünü təkmilləşdirmə və özünü inkişaf kimi bacarıqların inkişaf etdirilməsində xarici dil müəllimlərinin rolu danılmazdır. Aparılan elmi araşdırmalara, müşahidələrə əsasən müəllimlərin peşəkar inkişafının daim həyata keçirilməli və davamlı olaraq nəzarət edilməli bir proses olduğu aydın görünür. Tədrisdə peşəkar inkişaf müəllimlərin pedaqoji bilik və bacarıqlarını inkişaf etdirmək, keyfiyyətini artırmaqdır. Tədris metodunu təkmilləşdirmək, keçdiyi mövzulara dair sorğu-sual etmək, özünə inam qazanmaq, öyrənməyi öyrətməyə cəlb etmək, bölüşmək, təsir göstərmək, əməkdaşlıq etmək həm müəllimin, həm də şagirdin fəaliyyətini təkmilləşdirmək və yeni trendlərdən xəbərdar olmaqdır.

Açar sözlər: tendensiya, araşdırma, öyrənmə, dil, şifahi, yazılı, peşəkarlıq, inkişaf

İngilis dilini öyrənməyə başlamaq üçün ən yaxşı vaxtın nə vaxt olduğu sualı hələ də aktual olaraq qalır. Bu çətinlik ciddi araşdırma obyektinə olmuşdur. Dil öyrənmənin erkən tətbiqi ətrafında erkən müzakirələrin çoxu məktəblər kritik dövr fərziyyəsinə (CPH) əsaslanmışdır ki, bu da geniş şəkildə ifadə edilir.(2,12)

Bu sahədə anlayış aşağıdakıları təklif edir:

- dil öyrənmək üçün optimal yaşla bağlı araşdırmalar nəticəsizdir
- erkən başlanğıc uşaqların münasibətinə müsbət təsir göstərir
- erkən başlanğıcın yeganə üstünlüyü aktiv olaraq sərf olunan vaxtın ümumi miqdarıdır.

İngilis dilində akademik mükəmməllik giriş baxımından bir nömrəli prioritet olmalıdır. Nəticədə, bir çox ölkələrdə uşaqlar indi öyrənməyə başlayırlar. Tədris üçün ən uyğun yanaşma hansıdır. Gənc öyrənənlər?

Bu suala düzgün cavab yoxdur, çünki bu, bir çox amillərdən asılı olacaq: yaş uşaqların sayı, sinif ölçüsü, müəllimin səriştəsi, resursların mövcudluğu, məktəb konteksti və onu yaradan orqanlar tərəfindən qurulmuş çərçivə ərazi üçün təhsil mənzərəsi.

Şifahi inkişaf oxumaq və yazmaqdan əvvəl olmalıdır? Düşüncə məktəbi var Bu, uşaqların effektiv şəkildə modelləşdirilərək dili eşitməklə ən yaxşı öyrənmələrini təklif edir Bəzi kontekstlərdə uşaqları erkən oxumağa sövq etmək daha mənalı ola bilər.

Dil tədrisində müəllimlərin peşəkar inkişafını asanlaşdırmaq üçün müxtəlif yanaşmalar mövcuddur. Bu əsasda Burns and Richards (2009) peşəkar inkişaf fəaliyyətlərini əməkdaşlıq, tədqiqat və təcrübə yolu ilə təsnif edir. Richards and Farrell (2005) isə bu fəaliyyətləri necə həyata keçirildiyinə uyğun olmaqla fərdi, bərabər, qrup əsaslı, müəssisə çərçivəsi şəklində kateqoriyalara bölür və hər kateqoriya üzrə inkişaf bacarıqlarını ümumiləşdirir. Bu fəaliyyətlərə konfranslar, seminarlar, özünə nəzarət, həmkarları tərəfindən müşahidə, müəllimlərin portfeli, kritik hadisələrin təhlili, refleksiv təcrübə və fəaliyyət tədqiqatı daxildir.(4,46)

Təhsildə xarici dil müəllimlərinin peşəkar inkişafını təkmilləşdirmək üçün ilk olaraq mühüm problemlər və ehtiyaclar araşdırılıb tapılmalıdır. Müəllimlərin peşəkar inkişafı ilə əlaqəli qarşılaşdıqları çətinlikləri, ehtiyacları daha dərinlən öyrənməyə kömək edəcək araşdırmalara da ehtiyac vardır. Bu əsasda Özbilgin (2016), xarici dil müəllimlərinin peşəkar inkişafı ilə bağlı ehtiyaclarını araşdıraraq aşağıdakı təklifləri irəli sürür:

1. Xarici dil müəllimlərinin öz inkişafı üçün elmi konfransların, beynəlxalq və yerli təhsil layihələrin iştirakçısı olması.
2. Müəllimlər üçün uzunmüddətli seminar və praktikaların təşkilinin məqsədəuyğun hesab olunması.
3. İxtisasartırma üçün daha praktik tədbirlərin həyata keçirilməsi.
4. Öyrənmənin təşviqi üçün məktəblərarası əməkdaşlıq tədbirlərinin görülməsi.
5. Peşəkar inkişaf tədbirlərinin onların tədris kontekstinə uyğunluğunun nəzərə alınması.
6. Müəllimlər qərar qəbul etmə prosesində, tədbirlərdə fəal iştirak etmək istəyirlər. Belə olduqda, müəllimlər daha çox əməkdaşlığa, təcrübə mübadiləsinə ehtiyac və maraq duyurlar. Bu da müəllimlərin peşəkarlığını zənginləşdirir və öyrənməyə, öyrətməyə marağı artırır.
7. Müəllimlərin başqa məktəblərlə, həmkarları ilə qarşılıqlı əlaqə şəbəkəsi formalaşdırması.

Özünütəhsil, öz biliklərini təkmilləşdirmək, pedaqoji, elmi şuralarda, seminarlarda, konfranslarda, müsabiqələrdə, layihələrdə iştirak, müasir təlim texnologiyalarını, metodlarını mənimsəmək, yeni biliklərə-bacarıqlara yiyələnmək, informasiya-kommunikasiya texnologiyalarından səmərəli istifadə etmək, innovativ fəaliyyət, təqdimatların hazırlanması və təqdim olunmasında iştirak yuxarıda qeyd olunan fəaliyyət planının həyata keçirilməsi və reallaşdırılması yolları hesab oluna bilər.

ABŞ-ın Şimali Karolina Universitetinin professoru, “Nobel” mükafatı laureatı Əziz Sancar Bakıda Təhsil Nazirliyi və Azərbaycan Dövlət İqtisad Universitetinin (UNEC) birgə təşkilatçılığı ilə 12 iyun 2017-ci ildə tələbələrlə görüş zamanı dediyi kimi: “Özünüzə yaxşı müəllim seçin. Elə bir müəllim ki, peşəsinin şərəfli olduğunu anlamaqla yanaşı, onun məsuliyyətli, çətin və mürəkkəb bir iş olduğunu qəbul etsin” (Həsənova, 2018). Müəllim pedaqoji fəaliyyət müddətində bir sıra məqamlara diqqət yetirməlidir. Onun bilməli və bacarmalı olduğu məqamları Müseyib İlyasov “Müəllim peşəkarlığı və pedaqoji səriştəliliyin müasir problemləri” adlı monoqrafiyada aşağıdakı kimi qruplaşdırır(4,28)

Müəllim hazırlığında pedaqoji səriştəliliyin bir neçə növünü qeyd edə bilərik:

- qarşıya aydın məqsədlər qoymaq və onlara çatmaq üçün nəzəri biliklərə, praktik vərdişlərə yiyələnmək;
- psixoloji bacarıqlara sahib olmaq: buraya özünənəzarət, özünəəminlik, şagirdlərin fərdi psixoloji xüsusiyyətlərinə bələdlilik bacarığı, düşünmə, adaptasiya, mücərrədləşdirmə, təfəkkür və təxəyyülün sərbəstliliyi, aydınlığı, orjinallığı kimi keyfiyyətlər daxildir;
- pedaqoji prosesi nəzarətdə saxlamaq, obyektiv analiz və sintez etmək, qiymətləndirmək;

- öz üzərində fasiləsiz işləmək, yerli və xarici müvafiq ədəbiyyatlarla mütəmadi tanışlıq, təhsil sahəsində meydana çıxan yeni texnologiyaları mənimsəmək, qabaqcıl təcrübələrə istinad etmək;
- tədris prosesində şagirdlərin həm marağını, həm də fəallığını təmin etmək, bunun üçün ənənəvi və müasir metodların qarşılıqlı, integrativ formada təqdim olunması;
- yerli və dünyəvi dəyərlərin vəhdətdə tərbiyə olunması;
- təlim prosesində əks-əlaqənin təmin olunması;
- şagirdlərdə özünəəminlik, inamlılıq, problemlə vəziyyətdə obyektiv çevik qərarların verilməsi, sağlam rəqabətə girmək, tənqidi mühakimə yürütmək, fikirlərini əsaslandırmaq, qərar qəbul etmək, fikir müxtəlifliyinə hörmətlə yanaşmaq, fərdi və kollektiv əmək mühitinə uyğunlaşmaq kimi bacarıq və vərdislərin formalaşdırılması;
- yarana biləcək hər hansı anlaşılmaz şəraitdən, mübahisəli və narahatlıq yarada biləcək vəziyyətlərdən çevik, sürətli qərarlar qəbul edərək çıxmaq;
- məqsədə çatmaq üçün yeni innovasiyalardan səmərəli istifadə;
- ictimai-sosial həyatda müəllim şəxsiyyətini, nüfuzunu, amalını qoruyub saxlamaq;
- fəaliyyət göstərdiyi kollektivdə və şagirdlər arasında özünə inam, etibar, etimad qazanmaq;
- şəxsi məsuliyyət, dinləmək və anlayışla qəbul etmək bacarığı.
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The Impact of Teaching Collocations on Speaking Skills in English Language Learning

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Abstract

This article explores the impact of teaching collocations on the development of speaking skills in English language learning, emphasizing the central role of lexical chunks in verbal communication. Speaking remains one of the most challenging skills for second-language learners due to the cognitive complexity of real-time language processing. Therefore, effective vocabulary instructional techniques are crucial for enhancing oral proficiency. Collocation teaching, grounded in the Lexical Approach and supported by research on formulaic language, equips learners with ready-made linguistic units that significantly reduce mental processing load during speech production.

The article identifies several major benefits of collocation instruction, including improved oral fluency, enhanced grammatical and lexical accuracy, richer and more context-specific vocabulary knowledge, and greater pragmatic appropriateness. It also highlights the psychological dimension, noting that learners with strong collocational competence display increased communicative confidence, reduced anxiety, and a higher willingness to engage in spontaneous conversation.

By synthesizing theoretical viewpoints and pedagogical practices, the study argues that collocation-focused instruction should be integrated systematically into English language curricula. Findings demonstrate that teaching collocations not only supports more natural, idiomatic, and efficient speech but also prepares learners for authentic communication across diverse real-world settings. Consequently, collocation instruction emerges as a key and highly effective strategy for strengthening overall speaking proficiency in English as a foreign language.

Introduction

Speaking is a fundamental component of communicative competence and one of the most difficult skills for foreign language learners to acquire. Traditional vocabulary teaching approaches often rely on single-word memorization, which fails to prepare learners for the demands of spontaneous conversation. Collocations—frequently co-occurring word combinations—represent a more authentic and functional unit of language that supports real-time communication (Lewis, 1993).

Researchers such as Wray (2002) and Nation (2013) argue that mastery of formulaic sequences is essential for achieving fluency and naturalness in spoken English. This article examines how teaching collocations enhances learners' speaking skills and why collocational competence is key to effective communication.

2. Theoretical Background

2.1 The Lexical Approach and Collocations

Sinclair (1991) emphasizes that language is largely constructed through prefabricated chunks rather than freely generated grammar structures. Building on this idea, Lewis (1993) proposed the Lexical Approach, which positions collocations as central to language acquisition. Rather than

treating vocabulary as isolated items, this approach views language as an interconnected network of lexical combinations.

2.2 Formulaic Language Research

Formulaic language research suggests that learners store common phrases as whole units and retrieve them quickly during speech (Wray, 2002). This storage-and-retrieval mechanism reduces cognitive load and enhances the fluency of spoken language. Consequently, teaching collocations contributes significantly to learners' communicative competence.

3. The Impact of Teaching Collocations on Fluency

Fluency involves smooth, continuous, and coherent speech. Collocations help learners produce language rapidly because they function as pre-assembled lexical blocks. Studies by Nation (2013) show that learners who master lexical chunks experience fewer pauses, repetitions, and self-corrections during speech.

Expressions such as *make an effort*, *take responsibility*, or *highly successful* enable learners to express themselves more effortlessly. The automatic retrieval of such chunks leads to a more natural and uninterrupted speech flow.

4. The Impact on Accuracy

Accuracy refers to the correct and idiomatic use of linguistic forms. Many errors in learner speech result from incorrect collocational choices rather than grammatical mistakes (Hill, 2000). Teaching collocations helps learners avoid unnatural combinations—for example, *do a mistake* instead of *make a mistake*—thus improving the grammatical and lexical correctness of speech.

Accurate use of collocations contributes to clearer, more native-like communication and allows learners to convey meaning more precisely.

5. Contribution to Vocabulary Development

Collocation learning significantly contributes to the development of both **breadth** and **depth** of vocabulary knowledge. Traditional vocabulary teaching often emphasizes memorization of isolated words, which may leave learners unable to use them effectively in real-life contexts. In contrast, collocations present vocabulary in **meaningful combinations**, providing learners with ready-made units that are easier to retrieve and apply in speech. According to Schmitt (2010), vocabulary knowledge is more durable and functional when words are learned in collocational patterns, rather than as single, decontextualized items.

Learning collocations enhances semantic understanding because it allows learners to grasp **nuances of meaning** and **register differences**. For example, the verb *commit* can appear in different contexts: *commit a crime*, *commit suicide*, or *commit to a decision*. Each collocation conveys a specific meaning and carries different connotations. By learning words in combination, learners develop a deeper understanding of both the individual words and their appropriate contextual usage.

Moreover, collocation learning supports the development of **productive vocabulary**, enabling learners to use words accurately and naturally in speech. Learners who are familiar with collocations such as *make a decision*, *take responsibility*, *express an opinion*, or *pose a question* are better able to construct fluent and coherent sentences without hesitation. This is particularly important in speaking, where processing time is limited and real-time communication demands rapid language retrieval (Wray, 2002).

Collocations also facilitate **pattern recognition** in language learning. When learners observe and internalize common word combinations, they develop an intuitive sense of which words "fit together" in English. This contributes to **lexical creativity**, as learners can combine known collocations with new vocabulary to express ideas more precisely and naturally. For example, once

a learner knows the collocation *make an effort*, they may also produce related expressions like *make a good impression* or *make a significant contribution* by analogy.

Another advantage is the development of **receptive vocabulary skills**. Exposure to collocations in listening and reading activities allows learners to recognize familiar word combinations, improving comprehension and enabling more active participation in conversation. This dual benefit—both receptive and productive competence—makes collocation learning a highly efficient strategy for vocabulary development.

Finally, collocation instruction strengthens **long-term lexical retention**. Because words are learned in contextually meaningful clusters, they are stored as chunks in memory, making them easier to recall during speaking. Nation (2013) notes that repeated exposure and meaningful usage of collocations reinforce memory, allowing learners to retrieve words more quickly and use them appropriately in diverse communicative situations.

In summary, teaching collocations enhances vocabulary development by:

- Promoting deeper semantic understanding and register awareness
- Strengthening productive and receptive vocabulary skills
- Supporting pattern recognition and lexical creativity
- Improving long-term retention and recall
- Facilitating fluent and natural spoken language

Collocation-focused vocabulary learning is therefore essential for learners aiming to achieve both lexical richness and communicative competence in English.

6. Enhancement of Pragmatic and Communicative Competence

Effective oral communication requires understanding not only what to say, but how and when to say it. Collocations often carry pragmatic meanings that vary by context and register. Kasper and Rose (2002) argue that explicit instruction in pragmatic language enhances learners' ability to choose contextually appropriate expressions.

For instance, *take a break* vs. *take time off* differ in usage, tone, and formality. Teaching such distinctions helps learners communicate appropriately in academic, professional, or informal settings.

7. Increased Speaking Confidence

Confidence is a crucial affective factor in language learning. Learners equipped with a broad set of collocations feel more prepared for spontaneous interactions. According to MacIntyre (2007), reduced anxiety correlates strongly with improved willingness to communicate.

By providing learners with reliable lexical tools, collocation instruction fosters confidence, encourages risk-taking in communication, and reduces hesitation during speech.

8. Pedagogical Implications

The significant role of collocation knowledge in enhancing speaking proficiency highlights the need for teachers to integrate collocation-focused strategies systematically into English language instruction. Effective collocation teaching requires a combination of explicit instruction, meaningful practice, and continuous exposure to authentic language input. The following pedagogical considerations outline how collocations can be incorporated into classroom practice to maximize their impact on speaking development.

• Explicit teaching of high-frequency collocations

Teachers should prioritize high-frequency collocations that appear commonly in everyday communication. Research by Nation (2013) emphasizes that learners benefit most from the collocations that occur frequently across various oral contexts, such as *make progress*, *take*

responsibility, have a discussion, and greatly appreciate. Explicit presentation of these items—through explanation, examples, and contextualization—helps learners internalize them more effectively.

- **Using corpus-based resources**

Modern corpora such as the British National Corpus (BNC) and the Corpus of Contemporary American English (COCA) can be valuable tools for identifying authentic collocational patterns. Teachers can guide learners to use online concordances to explore how words co-occur in natural language. Corpus-based activities enable learners to notice lexical patterns, contextual nuances, and register differences (Sinclair, 1991). This promotes learner autonomy and helps them engage with real English usage.

- **Integrating collocations into speaking activities**

Collocations should be embedded in speaking tasks rather than taught only as vocabulary items. Classroom activities such as role-plays, debates, interviews, problem-solving tasks, and simulations can be designed to require the use of specific collocational patterns. For example, a debate on environmental issues might encourage the use of collocations like *take action, raise awareness, or make an impact*. Such targeted practice strengthens the connection between collocational knowledge and spontaneous speech production.

- **The role of noticing in collocation learning**

Schmidt's (1990) Noticing Hypothesis emphasizes that language learning occurs when learners consciously notice linguistic features in the input. Teachers can raise awareness of collocations by highlighting them in texts, videos, dialogues, and listening materials. Highlighting, underlining, color-coding, and attention-focusing tasks help learners consciously recognize collocations they might otherwise overlook.

- **Repetition, recycling, and retrieval practice**

Retention of collocations requires spaced repetition and meaningful recycling. Teachers should provide learners with multiple opportunities to encounter and produce the same collocations across different lessons and topics. Retrieval exercises, such as gap-fills, sentence completions, paraphrasing tasks, and oral drills, strengthen long-term memory and enhance automaticity in speech (Schmitt, 2010).

- **Corrective feedback focused on collocational errors**

Learners often produce collocational errors even at advanced levels. Teachers should provide gentle but explicit corrective feedback when learners misuse collocations during speaking tasks. Feedback strategies such as recasts, clarification requests, or metalinguistic explanations help learners adjust their lexical choices and internalize correct combinations.

- **Encouraging learner autonomy through collocation journals**

Maintaining a collocation notebook or digital log can help learners track new collocations, record example sentences, classify them by theme, and note context of use. This practice supports independent learning and strengthens lexical awareness. Learners can also categorize collocations based on the type (verb–noun, adjective–noun, verb–preposition combinations), which reinforces pattern recognition.

- **Using authentic materials to enhance exposure**

Authentic materials—such as movies, podcasts, interviews, news broadcasts, TED talks, and social media content—provide rich examples of natural collocational use. Teachers can design listening and speaking tasks around these materials to ensure learners hear collocations in meaningful contexts. Exposure to authentic input reinforces natural pronunciation, stress patterns, and pragmatic usage of collocations (Wray, 2002).

- **Integrating collocations into assessment**

Assessment practices should evaluate learners' collocational competence alongside grammatical and lexical knowledge. Oral exams, presentations, discussions, and speaking tests can include

rubrics that reward the correct use of natural and context-appropriate collocations. This encourages learners to prioritize collocational learning as part of their speaking development.

• **Addressing individual differences in learning**

Learners differ in cognitive style, motivation, and language exposure. Some learners may acquire collocations implicitly, while others require explicit instruction. Effective teachers adapt their methods to accommodate these differences, offering both structured learning opportunities and open-ended communicative practice. Motivation can also be enhanced by showing learners how collocations increase fluency and confidence in real-life communication.

In summary, the pedagogical implications of collocation instruction highlight the need for a balanced approach that combines explicit teaching, meaningful practice, corpus-informed learning, feedback, and authentic communication. When systematically implemented, these strategies significantly improve learners' ability to produce fluent, accurate, and natural English speech.

Conclusion

In conclusion, the teaching of collocations plays a pivotal role in enhancing the speaking skills of English language learners. Collocational competence not only facilitates the accurate and fluent production of speech but also contributes to learners' overall communicative efficiency. By providing learners with ready-made lexical units, collocation instruction reduces the cognitive demands of real-time language production, allowing learners to focus more on content and interaction rather than formulating each word individually.

The positive effects of collocation teaching are multidimensional. First, it significantly improves fluency, enabling learners to speak more smoothly with fewer pauses, hesitations, or self-corrections. Second, it enhances accuracy, as learners become aware of idiomatic and grammatically correct combinations, reducing errors that arise from improper word pairing. Third, collocation learning deepens vocabulary knowledge, equipping learners with contextually appropriate and semantically rich language that can be used flexibly across different speaking situations. Fourth, it promotes pragmatic competence, allowing learners to choose expressions that align with the social, cultural, and situational context, thereby producing more natural and socially appropriate speech. Fifth, collocation-focused instruction boosts learner confidence, reducing anxiety during oral communication and increasing willingness to participate in discussions, debates, presentations, and informal conversations.

From a pedagogical perspective, integrating collocations into the curriculum offers both practical and theoretical advantages. Systematic exposure to collocations through explicit teaching, authentic materials, corpus-based activities, and communicative tasks ensures that learners internalize these lexical chunks and use them automatically in speaking. Furthermore, repeated practice, feedback, and the maintenance of collocation journals reinforce learning and foster learner autonomy.

Ultimately, collocation instruction represents a crucial strategy for achieving balanced oral proficiency. It bridges the gap between grammatical knowledge and real-world communication, preparing learners not only to produce correct sentences but also to communicate naturally, effectively, and confidently in English. Given the increasingly globalized and communicative nature of language use, educators should prioritize collocation teaching as an integral part of English language pedagogy to ensure learners develop both competence and confidence in spoken English.

In short, teaching collocations is not merely a vocabulary enhancement strategy—it is a transformative pedagogical approach that equips learners with the tools necessary for fluent, accurate, and contextually appropriate oral communication, ultimately fostering greater success in both academic and real-life English interactions.

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Enhancing Paragraph and Essay Skills through Guided Discovery

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Abstract

This article explores the application of guided discovery and rubric-based instruction in developing Grade 11 students' paragraph writing skills, particularly in exam preparation contexts. Guided discovery, as a scaffolded learning approach, engages learners in noticing patterns, generating hypotheses, and constructing rules independently, thereby promoting deeper cognitive processing, metacognitive awareness, and learner autonomy. The study also highlights the role of rubrics in providing clear expectations, supporting self-regulation, and enhancing writing performance. An experimental implementation demonstrated that students who engaged in structured guided discovery tasks, combined with rubric-guided self-assessment, achieved improved paragraph cohesion, clarity, and overall writing quality. The findings underscore the pedagogical effectiveness of scaffolded discovery and structured feedback in fostering active learning, motivation, and transferable writing strategies.

Keywords: Guided discovery, Paragraph writing, Rubrics, EFL education, Exam preparation

Guided discovery — the carefully scaffolded process by which learners are led to notice patterns, test hypotheses, and construct rules themselves — is central to effective language teaching because it changes learning from passive reception into active knowledge construction. Bruner's insistence that "to instruct someone... is not a matter of getting him to commit results to mind. Rather, it is to teach him to participate in the process that makes possible the establishment of knowledge" 1 (p. 72) re-frames the teacher's role from knowledge-depositor to designer of productive learning conditions. When instruction privileges process over rote product — when, in Bruner's words, the aim is "to facilitate a child's thinking and problem-solving rather than to provide the facts" 1 (p. 14) — learners are engaged in active sense-making: they manipulate evidence, generate and test hypotheses, and thereby internalize generalizations on their own terms. This matters for language classrooms in two intertwined ways. First, the cognitive work involved in deriving a rule from examples forces deeper processing than copying a rule off the board: when learners actively compare, contrast, and infer, memory traces are consolidated into usable knowledge. Brown amplifies this point in his discussion of inductive and deductive reasoning, noting that inductive procedures encourage hypothesis formation and deeper cognitive processing — processes linked to better retention and learner autonomy 2 (pp. 110–115). Second, discovery tasks provoke noticing: learners attend to the salient features of the input because they need them to solve a task. Harmer emphasizes this mechanism, arguing that well-designed discovery tasks provoke noticing and ownership of the grammar or lexis being learned, which supports transfer to production 3 (pp. 48–52; 210–214). Pedagogically, guided discovery is superior to unguided discovery because the "guided" element provides the scaffolding that prevents cognitive overload and keeps learners focused on productive generalization. Scrivener illustrates this in classroom terms: the teacher sequences tasks so learners experience the right amount of challenge, offers prompts and clues rather than full explanations, and gradually withdraws support as learners' competence increases 4 (pp. 267–274). Thornbury's practical

treatment of grammar teaching shows the same logic at the micro level: learners who reach grammatical generalizations through structured examples and focused tasks demonstrate stronger 'noticing' and longer-lasting control than those who simply received deductive rules up front 5 (pp. 51–62). These converging lines of theory and practice make clear why guided discovery should be central to curriculum design: it fosters metacognitive skill (learners learn how to learn), cognitive robustness (deeper processing and hypothesis-testing), and affective investment (ownership and motivation). From a formative-assessment perspective, discovery tasks naturally generate diagnostic information the teacher can use to tailor follow-up activities; as learners attempt to solve an inductive task, their errors and hypotheses reveal the state of their interlanguage and thus the next instructional step — precisely the kind of responsive teaching Bruner envisaged when he reframed instruction as participation in knowledge-making 1 (p. 72). Practically speaking, guided discovery is versatile: it supports vocabulary learning through collocation-sorting tasks, grammar through example-analysis and rule-building, pronunciation through focused listening and generalization, and writing through iterative problem-solving tasks where readers' expectations or discourse markers are teased out empirically. Importantly, guided discovery is not the same as discovery without support; it is a carefully managed route between teacher-led exposition and unguided trial-and-error, calibrated so learners still reach correct generalizations while doing the cognitive work themselves. Research syntheses of inductive teaching methods (e.g., Prince & Felder; review literature cited in Brown) report that inductive designs often produce deeper conceptual learning and better retention when appropriately scaffolded — outcomes that align with Bruner's argument that education should facilitate thinking and problem-solving rather than simple fact-transmission 1 (p. 14). For classroom teachers, therefore, the design principles are straightforward: present meaningful data or examples that foreground the target feature; pose a task that requires the learner to infer the pattern; provide prompts, guiding questions and limited feedback; and finally, consolidate the generalization explicitly once learners have arrived at it. When implemented in this way — following the theory of learning-as-construction and the practical sequences described by Scrivener 4 and Thornbury 5 — guided discovery becomes both a cognitive engine for durable learning and a vehicle for classroom empowerment: students gain not only linguistic knowledge but also strategies for independent problem-solving, which in turn supports lifetime learning beyond the classroom. In short, guided discovery matters because it aligns powerful cognitive mechanisms (hypothesis-testing, noticing, elaborative processing) with humane pedagogy (learner autonomy, motivation, scaffolded support), exactly what Bruner urged when he reframed instruction as the facilitation of active knowledge-making rather than the transmission of inert facts 1 (pp. 14, 72).

Providing students with a rubric prior to an exam or assignment is widely recognized as a powerful strategy to enhance learning, self-regulation, and performance. A rubric functions as a structured guide that clearly articulates expectations, listing the criteria for quality work and performance levels across a continuum 6 (pp. 1–20). Empirical evidence shows that when learners have access to rubrics before completing tasks, they are better able to plan, monitor, and adjust their work, which in turn improves self-regulation and metacognitive awareness 7 (pp. 627–650). Jonsson and Svingby highlight that the use of scoring rubrics enhances the reliable scoring of performance assessments and facilitates valid judgments of complex competencies 8 (pp. 130–144). By making expectations explicit, rubrics reduce ambiguity, promote fairness, and increase transparency in assessment, ensuring that all students are evaluated against the same standards. Furthermore, the 2022 study by Brunstein et al. indicates that rubric use significantly reduces cognitive load during self-assessment, allowing learners to focus more effectively on the quality of their work 7 (pp. 627–650). Beyond cognitive benefits, rubrics also improve students' confidence and motivation by providing clear indicators of what constitutes high-quality performance 8 (pp. 130–144). In practical terms, sharing rubrics before an assessment enables learners to understand the

essential components of the task, engage in self-directed planning, and anticipate the instructor's evaluative criteria. Consequently, rubric provision not only supports improved academic performance but also fosters autonomous, reflective learning, reduces anxiety, and enhances students' ability to internalize expectations, making it an indispensable tool in contemporary pedagogy.

Effective paragraph writing is a foundational skill in academic writing, as it allows the writer to convey ideas clearly and coherently while guiding the reader through complex arguments. Central to this skill is the topic sentence, which functions as the controlling idea for the paragraph and ensures that all subsequent sentences support a single main point. As noted in *The Science of Academic Writing*, "A paragraph starts with an opening, also called the topic sentence(s), which indicates the contents of the paragraph and ends with a concluding sentence" 9 (p. 20). This structure ensures that the paragraph maintains unity and that the reader can easily identify the main idea. Similarly, Bailey (2011) emphasizes in *Academic Writing: A Handbook for International Students* that paragraphs are "the basic building blocks of academic writing" and that well-structured paragraphs help the reader follow the argument by dividing the text into manageable and coherent sections 10 (pp. 45–46). Without a clear topic sentence, paragraphs risk becoming disorganized, presenting unrelated or tangential information that confuses the reader and weakens the argument.

Empirical research confirms the pedagogical importance of topic sentences, particularly in EFL contexts. A study examining EFL learners' paragraph writing found that students who failed to include a clear controlling idea often produced paragraphs lacking unity and coherence 11 (pp. 12–15). The authors concluded that explicit instruction in writing topic sentences and structuring paragraphs significantly improved students' ability to maintain paragraph unity and coherence. Similarly, in a 2022 study on EFL students' descriptive paragraph writing, researchers observed that paragraphs without a clearly stated controlling idea had lower ratings for cohesion and overall quality, underscoring the role of topic sentences in guiding both the writing and reading process 12 (pp. 7–10). These findings indicate that teaching students how to construct effective topic sentences is not only a matter of form but also a crucial factor in enhancing the clarity and persuasiveness of academic writing.

Topic sentences serve multiple cognitive and communicative functions. They provide the writer with a roadmap, clarifying the purpose of the paragraph and ensuring that all supporting sentences relate directly to the main point. For the reader, they act as signposts that highlight the key idea of the paragraph and facilitate comprehension. According to the Rochester Institute of Technology's writing center, "Paragraph unity requires that all supporting sentences relate to the topic sentence, which functions as a guide for development" 13 (p. 2). In this way, topic sentences help manage both writer intention and reader expectation, increasing the effectiveness of communication. Furthermore, research in EFL contexts demonstrates that explicit instruction in topic sentences reduces student errors, enhances paragraph cohesion, and improves overall writing quality 11 (pp. 12–15). These benefits are particularly salient for learners whose first language does not follow the same conventions of paragraph structure in English, making clear guidance on topic sentences indispensable.

Experimental Application in Grade 11 Exam Preparation

In the context of Grade 11 exam preparation, guided discovery was applied to scaffold learners' paragraph writing skills for the State Exam Center assessments. The experiment followed a structured sequence: first, students analyzed the writing prompt, identifying key requirements such as word count, style, and tense; second, they located relevant sentences in reading material to support their arguments, linking comprehension with writing tasks; third, learners generated topic sentences, supporting ideas, and concluding statements using guided templates and metacognitive reflection. Following the first draft, students engaged in grammar and spelling

checks, peer-review sessions, and AI-assisted revision to refine their work. Finally, learners evaluated their paragraphs against a rubric provided in advance, which allowed for self-assessment and informed corrective action. This structured implementation of guided discovery promoted active engagement, enhanced metacognitive awareness, and improved paragraph cohesion and clarity, demonstrating the pedagogical effectiveness of scaffolded discovery tasks for exam-oriented writing.

In conclusion, integrating guided discovery into exam preparation enables students not only to internalize linguistic structures but also to develop autonomous problem-solving skills and self-regulated learning strategies. The empirical and theoretical foundations outlined above confirm that guided discovery, when coupled with explicit rubrics and structured reflection, produces measurable gains in writing performance and cognitive engagement, making it a highly effective instructional strategy for Grade 11 learners.

Conclusion

Integrating guided discovery with explicit rubric use offers a highly effective instructional approach for enhancing students' paragraph writing skills in exam-oriented contexts. By encouraging learners to analyze examples, infer patterns, and evaluate their own work, this approach promotes not only linguistic knowledge but also autonomous problem-solving and self-regulated learning strategies. The practical implementation shows that scaffolded discovery tasks enhance engagement, metacognitive awareness, and the quality of student writing. Overall, guided discovery combined with structured feedback creates a learning environment that supports durable knowledge acquisition, learner empowerment, and long-term academic development

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УДК 81.13

Использование искусственного интеллекта в образовательном процессе

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Аннотация: В этой статье рассматриваются ключевые аспекты использования искусственного интеллекта в образовании, включая его преимущества, проблемы и перспективы развития.

Abstract: This article explores the key aspects of using AI in education, including its benefits, challenges, and development prospects.

Интеграция искусственного интеллекта (ИИ) в образовательную сферу становится неотъемлемой частью современного образовательного процесса. ИИ предлагает новые возможности для персонализации обучения, автоматизации административных задач и повышения эффективности образовательных практик.

В последние годы наблюдается стремительное внедрение ИИ в образовательные учреждения по всему миру. В Казахстане, например, 95 вузов уже интегрировали новые дисциплины, связанные с ИИ, в свои учебные программы. Министерство образования и науки Республики Казахстан утвердило «Концептуальные основы внедрения ИИ на 2025–2029 годы», что свидетельствует о государственной поддержке и стратегическом подходе к интеграции ИИ в образование [1].

Международные организации также признают важность ИИ в образовании. ЮНЕСКО посвятило Международный день образования 2025 года искусственному интеллекту, подчеркивая необходимость инвестиций в подготовку преподавателей и студентов для разумного использования этой технологии в образовательном процессе.

ИИ позволяет адаптировать образовательный процесс под индивидуальные потребности каждого учащегося. Системы на основе ИИ могут анализировать успеваемость студентов, выявлять их сильные и слабые стороны, предлагая соответствующие материалы и задания для улучшения результатов. Это способствует более глубокому усвоению материала и повышению мотивации учащихся.

ИИ может значительно упростить административную работу в образовательных учреждениях. Автоматизация процессов, таких как оценка домашних заданий, составление расписаний и обработка заявок, позволяет освободить время преподавателей и административного персонала для более важных задач [2]. На рисунке 1 показаны основные направления использования ИИ в образовании.

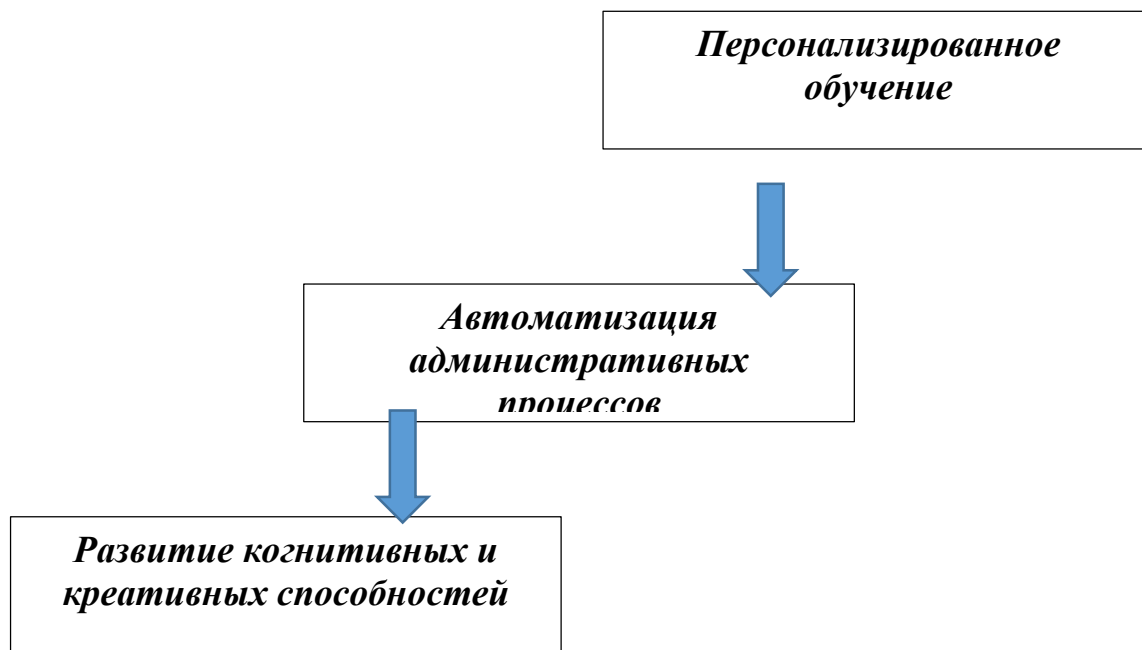


Рисунок 1 - Основные направления использования ИИ в образовании

Использование ИИ в обучении способствует развитию когнитивных и креативных способностей учащихся. Системы на основе ИИ могут предоставлять учащимся разнообразные задания, стимулирующие критическое мышление, решение проблем и творческий подход к обучению.

Внедрение ИИ в образование вызывает ряд этических и правовых вопросов. Необходимо обеспечить защиту персональных данных учащихся, предотвратить дискриминацию и обеспечить прозрачность алгоритмов, используемых в образовательных системах.

Для эффективного использования ИИ в образовательном процессе необходимо подготовить педагогов, обладающих необходимыми знаниями и навыками. Это включает в себя обучение использованию ИИ-инструментов, а также понимание их возможностей и ограничений.

Внедрение ИИ в образование требует наличия соответствующей технической инфраструктуры, включая высокоскоростной интернет, современные компьютеры и программное обеспечение. В некоторых регионах, особенно в развивающихся странах, отсутствие такой инфраструктуры может стать серьезным препятствием для внедрения ИИ в образовательный процесс.

Будущее образования связано с интеграцией мультимодальных ИИ-систем, способных обрабатывать текстовую, аудиовизуальную и сенсорную информацию. Такие системы могут создавать более интерактивные и погружающие образовательные среды, способствующие лучшему усвоению материала.

Перспективы развития ИИ в образовании включают в себя не замену преподавателей, а их сотрудничество с ИИ-системами. ИИ может выполнять рутинные задачи, освобождая время преподавателей для более творческой и индивидуальной работы с учащимися[3].

Университет Мирас активно интегрирует ИИ в свою образовательную систему, предлагая студентам и преподавателям инновационные инструменты для улучшения учебного процесса. В частности, университет разработал собственный образовательный

портал, который поддерживает дистанционные технологии обучения, позволяя студентам обучаться и сдавать экзамены в удобное время и месте [4].

Кроме того, университет активно сотрудничает с международными образовательными учреждениями, такими как Сеульский Кибер университет, что способствует обмену опытом и внедрению передовых технологий в образовательный процесс.

Использование искусственного интеллекта в образовательном процессе открывает новые горизонты для персонализации обучения, автоматизации административных задач и развития когнитивных способностей учащихся. Однако для эффективного внедрения ИИ необходимо учитывать этические, правовые и технические аспекты, а также обеспечить подготовку педагогов и наличие соответствующей инфраструктуры. Будущее образования связано с гармоничным сочетанием возможностей ИИ и человеческого потенциала, что позволит создать более эффективную и доступную образовательную среду.

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Speak AI және ELSA Speak секілді жасанды интеллект құралдарының орта буын оқушылардың айтылым және еркін сөйлеу дағдыларын дамытуға әсері

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Аңдатпа: Ғылыми мақалада орта мектеп оқушыларын шет тілінде ауызекі сөйлеуге және айтылым дағдысына үйретуде жасанды интеллектке негізделген құралдарды оқыту процесіне енгізу және олардың оқушылардың сөйлесім дағдыларын дамытуға тигізетін әсері мен қиындықтары талқыланады. Жасанды интеллектке деген сұраныстың салыстырмалы деңгейде көбейіп жатқанымен, оны оқу процесіне тиімді енгізу мәселелері жайлы да сұрақтар туындауда. Осы тұрғыда, зерттеу жұмысы ELSA Speak секілді дауыстық чат-боттарды қолданудың артықшылықтары мен кемшіліктерін қатар көрсетіп, оқушылардың жеке тәжірибесіне сүйенген сандық және сапалық ақпараттарды көрсетеді.

Түйінді сөздер: жасанды интеллект, айтылым, ауызекі сөйлеу, ELSA Speak, орта буын оқушылары, шет тілі.

Abstract: This article explores the integration of artificial intelligence-based tools into the teaching process to develop middle school students' pronunciation and speaking skills in a foreign language. Although the demand for artificial intelligence is steadily increasing, questions also arise regarding the effective implementation of such technologies in education. In this context, the study examines both the advantages and disadvantages of using voice chatbots such as ELSA Speak, presenting quantitative and qualitative data based on students' personal experiences.

Keywords: artificial intelligence, pronunciation, speaking, ELSA Speak, middle school learners, foreign language

Аннотация: В научной статье рассматривается внедрение инструментов, основанных на искусственном интеллекте, в процесс обучения для формирования у учащихся средних классов навыков произношения и говорения на иностранном языке. Несмотря на сравнительно растущий спрос на искусственный интеллект, возникают вопросы, связанные с его эффективным применением в образовательном процессе. В этом контексте исследование показывает как преимущества, так и недостатки использования голосовых чат-ботов, таких как ELSA Speak, опираясь на количественные и качественные данные, основанные на личном опыте учащихся.

Ключевые слова: искусственный интеллект, произношение, говорение, ELSA Speak, учащиеся средней школы, иностранный язык.

Кіріспе

Айтылым дағдысының тіл үйрену процесінде әсіресе өзгелермен қарым қатынас орнатуда алатын орны айрықша зор. Себебі, айтылым дағдысы тыңдалым және оқылым дағдылары секілді ақпаратты қабылдау ғана емес, шығаруды көздейтін өнімді дағды болып табылады. Ауызекі сөйлеуге үйрену шет тілін өмірде тиімді мақсатта қолдануда ерекше көмегін тигізетіні сөзсіз.[1] Дәстүрлі оқыту оқушыларды шет тілінде еркін сөйлеуге үйретуде ауызша тапсырмалар мен талқылаулар өткізу арқылы сабақты ұйымдастырады. Бұл үрдіс коммуникациялық құзыреттілікке негізделгенмен, көп жағдайда сабақта қалыптасуы мүмкін қысымға, оқушының сенімсіздігіне байланысты тиімсіз болды. Сондықтан, жаңа цифрланған қоғамда аталған әдістер өз өзектілігін жойып, оқу процесін ұйымдастыру инновациялық технологиялар негізінде жүргізе асырылып келуде. Осы секілді жаңалықтардың бірі және бірегейі - оқыту үрдісіне жасанды интеллектке негізделіп құралған оқыту материалдарын енгізу. Жасанды интеллекттің маңыздылығы туралы Қазақстан Республикасының Президенті Қасым-Жомарт Кемелұлы Тоқаев «Қазақстан жасанды интеллект дәуірінде: цифрлық трансформация арқылы өзекті міндеттер мен оларды шешу» атты Қазақстан халқына Жолдауында былай деп үндеді: *“Жасанды интеллектінің қарқынды дамуы қазірдің өзінде халықтың, әсіресе, жастардың мінез-құлқы мен болмыс-бітіміне әсер етіп жатыр. Басқаша болуы мүмкін емес. Себебі бұл үрдіс бүкіл әлемде қалыптасқан тәртіпті және адамдардың өмір сүру салтын біржола өзгертуде. Біз бұған дайын болып, батыл әрекет етуіміз керек. Әйтпесе артта қалудың салдары өте ауыр болады.”*[2]

Зерттеу сұрақтары:

- Жасанды интеллектке негізделген құралдардың, оның ішінде ELSA Speak бағдарламасының құрылымы қандай?
- ELSA Speak бағдарламасын қолданушылардың жасанды интеллект құралдарының айтылым дағдысын дамытудағы рөлі туралы негізгі ойлары қандай және қандай ұсыныстар келтіріледі?

Әдістеме

Жасанды интеллектті оқыту үдерісіне енгізу сабақтарды интерактивті және танымды етіп өткізудің кепілі болуға күтілуде. Осы орайда, шет тілінде ауызекі сөйлеуге үйренуде жасанды интеллект құралдарының ұсынатын мүмкіндіктері жайлы болжамдар көп. Мысалы, ELSA Speak құралы тіл үйренушілерге көрсететін тез арадағы кері байланысы, айтылымда жіберетін дыбыстық қателерді түзеумен қатар, сыныптан тыс уақытта да қолдануға тиімділігімен ерекшеленеді. Бағдарлама ұсынған жүздеген сабақтар ағылшын тілінің CEFR (Common European Framework of Reference for languages)[3] бойынша көрсетілге әртүрлі деңгейіне сәйкес етіліп жасалған және оқушы өз ыңғайына байланысты жасанды интеллект бойынша оқу процесін жүргізетін тьюторды таңдай алады.Толығырақ айтатын болсақ:

- Біріншіден, бұл құрал интерактивті негізде болғаны үшін, сабақ барысының қызықты өтуіне, оқушылардың мазасыздық деңгейінің азаюына жағдай жасайды.
- Екіншіден, қолданба шынайы өзара әрекеттесуді имитациялайды, бұл оқушылардың әртүрлі тақырыптарда дискуссия жасауы арқылы қатесіз еркін сөйлеуін қалыптастырады.
- Үшіншіден, ЖИ құралының қолжетімділігі мен икемділігі қолданушылардың кез-келген уақытта және жерде өз бетінше практика жасауына мүмкіндік береді.

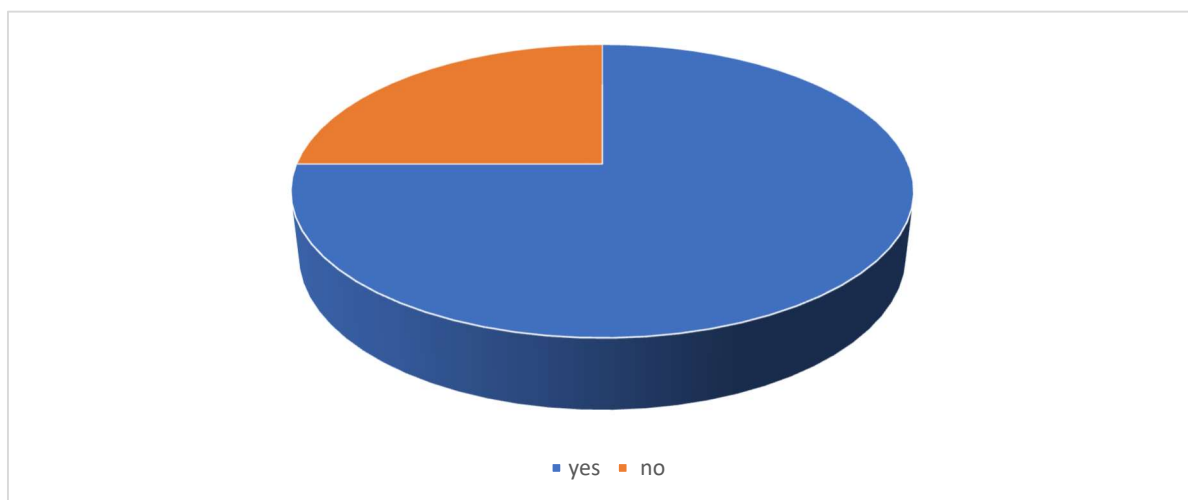
Тілдік мүмкіндіктерден бөлек, ЖИ технологиялары тұлғаның өзі-өзі реттеуін жақсартатын танымдық және метанымдық стратегияларды дамытады. Яғни, ЖИ-ке негізделген құралдарды қолдану арқылы оқушылар алдына жеке мақсаттар қоюға, өз

дамуын бақылай және бағалай білуге жаттыға алады.[4] Мотивациясы жоғары студент тілдік, психологиялық және тәрбиелік мәселелермен тиімді жұмыс жасай алатыны дәлелденген.[5]

Практикада қолдану

Жоғарыда аталған әдістеме негізінде 9-сынып оқушылары арасында аралас әдісті (mixed method) қолданылып, сауалнама арқылы сандық және сапалық деректер алынды. Сауалнама Google form онлайн платформасы арқылы құрастырылып, барлығы 10 жабық сұрақ (Likert шкаласы бойынша) пен 3 ашық сұрақты қамтиды. Сауалнамада ELSA Speak қолданбасын пайдаланған оқушылардың субъективті бағасы мен оның тиімділігі мен кемшіліктеріне қатысты ұсыныстары жазылған. Барлық қатысушыларға зерттеу мақсаты түсіндірілген және жауаптардың құпиялылығы сақталған.

Сауалнама нәтижелеріне сәйкес 75% оқушы қолданбаны біледі және оның құрылымымен таныс екені анықталды, дегенмен қалған 25% пайыздық көрсеткіш бұл қолданбаның әлі де үйренушілер арасында таңсық дүние екенін дәлелдеп, әрі қарай қолданысқа енгізілуі керектігін үндейді. (1-сурет)



1-сурет. Оқушылардың қолданбасын қолдануының пайыздық көрсеткіші

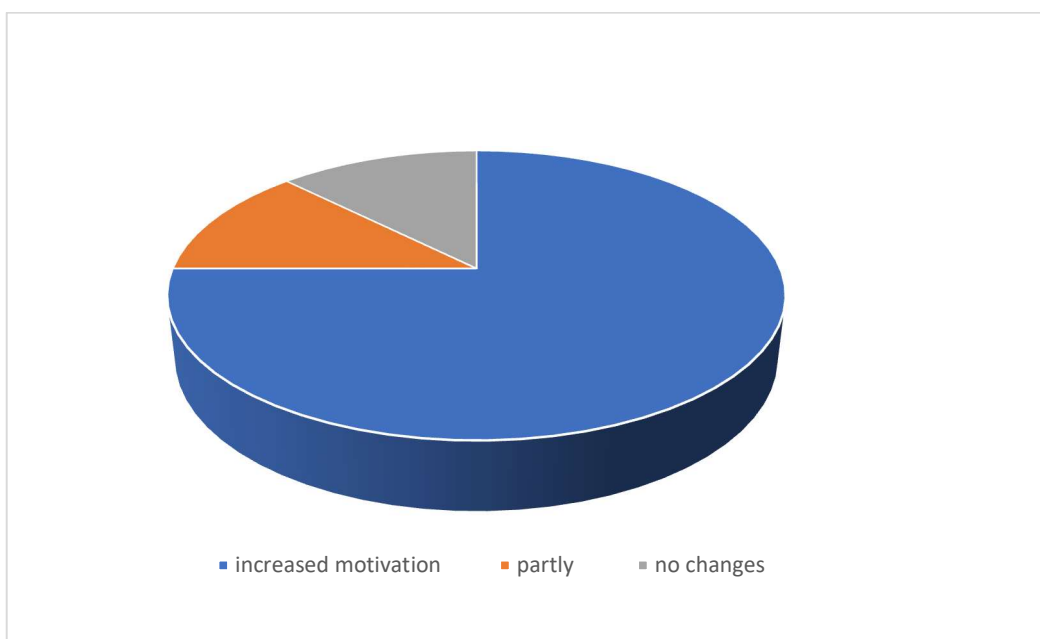
Зерттеуде көрсетілгендей, “Сен бағдарламаны қаншалықты жиі қолданасың?” деген сұраққа 12,5% оқушы “күнделікті” деп жауап берсе, дәл осыншама оқушы сирек қолданатынын көрсеткен. 25% пайыздық үлес қолданбаны айына бір рет, аптасына бір рет және мүлдем қолданбайтын оқушылардың таңдауына түсті.

Дегенмен, ауызекі сөйлеу мен айтылым дағдысына қатысты тигізген пайдасы мен байқалған өзгерістер туралы 50% пайыз оқушылар жауап берген, бұл жағымды көрсеткіш қолданбаның мүмкіндіктерін растап, әрі қарай тәжірибеге тереңірек енгізілу маңызын түсіндіріп тұрғандай. (1- кесте)

Жауап	«ELSA Speak қолданбасы айтылым дағдысы жақсартуға көмектесті ме?»	«ELSA Speak қолданбасы ауызекі сөйлеуді дамытты ма?»
<i>Иә, пайдасы бар</i>	50%	50%
<i>Кішкене өзгеріс байқадым</i>	25%	20%
<i>Ешқандай өзгеріс жоқ</i>	25%	30%

1-кесте. Оқушылардың бағдарламаның тиімділігіне берген бағасы пайыздық көрсеткішпен

Сонымен қатар, қолданбаны қолдану үйренушілердің мотивациясын көтеруге көмектескені келесідей көрсеткіштермен берілген: 75% оқушы жағымды әсер қалдырса, қалған әр 12,5% пайыз «жартылай» және «мүлдем» деген жауаптарды таңдаған. (2-сурет) Алынған нәтижеге сәйкес, балалардың жеке танымдық ерекшеліктері мен жүйені қолдана алудағы айырмашылықтары да рөл ойнап тұр. Демек, жасанды интеллектке негізделген дауыстық чат-боттармен жұмыс жасап, оны оқу үдерісіне енгізу барысында артықшылықтар мен қатар болжамды кемшіліктермен де жұмыс жасау қажеттілігі туады.



2-сурет. Қолданбаның оқушының шет тілін оқуға мотивациясына әсері

Сауалнамада көрсетілген ашық сұрақтар негізінде оқушылардың құралын қолданудағы өз ойларымен бөлісті. Бір оқушы *After using ELSA Speak, I noticed that my pronunciation became clearer and more accurate. For example, I learned how to reduce my accent when pronouncing difficult sounds like /th/ in words such as “think” and “though.” The app also helped me improve my intonation and stress patterns. Now I can speak more confidently because I know which syllables to emphasize in longer words like “communication” and “environmental.”* деп түсіндірді, яғни, құралдың көмегімен оқушы өзінде ағылшын тілінде сөйлеу барысында кездескен дыбыстық қателермен сәтті жұмыс жасай алғанын жекізді.

Жақсы әсерлермен бірге қолданбаны қолдануда кездескен қиындықтар туралы да жауаптар кездесті, ең алғашқы сұрақ қойылған жер ол қолданбада қазақ тілін таңдау туралы опциясын болмауы. Бұл қазақ тілде оқитын оқушыларға оқытуда белгілі бір келіспеушіліктер тудыруы әбден мүмкін деген алаңдаушылық жеткізілді. Бұл көрсеткіш арқылы жасанды интеллект құралдары тек қана мұғалімнің қызметін және оқу процесін қолдайтын негізгі көмекші бола алатынын, яғни, олардың оқытушы қызметін толықтай алмастыра алмайтынын көрсетеді.

Зерттеу нәтижесіне сай берілетін ұсыныстар: университеттер немесе мектептер секілді оқу орындарында жасанды интеллект құралдарын толығымен тең тұрғыда қолдана алуға мүмкіндік болу шарт. Себебі, оқушылар қолданбаның мүмкіндіктерін толықтай қолдана алу үшін оның премиум нұсқасын сатып алуға барлық тіл үйренушілердің мүмкіндіктері келе бермейтінін жеткізді. Бұл инновациялық енгізулер болғандықтан, мектеп не жоғары оқу орны кадрларын да жаңалыққа бейімдеу де өте маңызды.

Қорытындылай келе, зерттеу жұмысы жасанды интеллект құралдары көмегімен оқушыларды еркін сөйлеу мен айтылым дағдысына үйретудің негізгі артықшылықтары мен мүмкін болатын қиындықтар атап көрсетті. Кейбір оқушылар қолданбаны дыбыстарды дұрыс айтуға үйретуде пайдасы зор екенін, оқу процесін жеңілдетіп, сенімді орта қалыптастырудағы артықшылықтарын ашық сұрақтық тапсырмада атап көрсетсе, енді бірі құралдың мазмұнымен толық таныс емес екенін жеткізген. Ескеретін жайт, ЖИ құралдары оқу бағдарламасының тек көмекші құралы ретінде қарастыра отырып жиі қолдану, алынған нәтижелерді тұрақты салыстырып отыру жақсы нәтижелерге жеткізеді.

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Анализ изменений показателей образовательных целей после повторного картирования учебной программы старшей школы по математике

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Образовательная программа NIS-Programme — была разработана для НИШ в 2012 году совместно со стратегическим партнером — Международным экзаменационным советом Университета Кембридж — на основе интеграции лучшего национального и международного опыта. В 2022 году была начата работа по пересмотру учебных программ с фокусом на развитие ключевых компетенций, включающую перечень ценностей, знаний, видов грамотности и навыков, которые являются фундаментальной основой для обучения. В 2024–2025 учебном году пересмотренная учебная программа основной школы внедрилась в 7 и 8 классах НИШ. Учебные программы основной и старшей школы пересмотрены с фокусом на формирование у учащихся ключевых компетенций для успешной жизнедеятельности в современном быстро меняющемся мире.

Настоящий материал представляет собой результаты оценки эффективности учебной программы старшей школы по предмету «Математика», проведенной путем повторного картирования. При повторном картировании учебных программ старшей школы были проанализированы пересмотренные учебные программы. Проведено повторное картирование всех целей обучения учебной программы. Было проведено повторное оценивание каждой цели обучения по 4-бальной системе (1 – не заданы в этой цели обучения, 2 – не заданы в этой цели обучения, но есть некоторые возможности для учителей включать это при преподавании для достижения этой цели обучения, 3 – частично задана в этой цели обучения, 4 – главная цель).

При повторном картировании учебных программ старшей школы были проанализированы пересмотренные учебные программы:

Критерий	Показатель до изменений	Показатель после изменений	Общий тренд (формула)
Всего по видам грамотности (среднее значение)	12%	12%	0%
Функциональная грамотность	88%	98%	10%
Финансовая грамотность	5%	4%	-1%
Предпринимательская грамотность	10%	6%	-4%
Правовая грамотность	0%	0%	0%
Экологическая грамотность	0%	0%	0%
Грамотность для устойчивого развития	0%	0%	0%
Физическая грамотность	0%	0%	0%
Грамотность в области здоровья (медицинская)	0%	0%	0%
Медиа и информационная грамотность	0%	0%	0%
Цифровая грамотность	13%	11%	-2%
Грамотность работы с данными	16%	13%	-3%
Грамотность в области программирования и кодирования	15%	14%	-1%

Критерий	Показатель до изменений	Показатель после изменений	Общий тренд (формула)
Всего по навыкам (среднее значение)	37%	44%	↑ 7%
Критическое мышление	76%	95%	↑ 19%
Креативное мышление	76%	92%	↑ 16%
Решение проблем и принятие решений	82%	97%	↑ 15%
Исследовательские навыки	63%	77%	↑ 14%
Учиться тому, как учиться	76%	92%	↑ 16%
Саморегуляция	16%	21%	↑ 5%
Вычислительное мышление	76%	92%	↑ 16%
Системное мышление	86%	99%	↑ 13%
Сотрудничество	84%	94%	↑ 10%
Коммуникация	84%	94%	↑ 10%
Социальная ответственность	0%	0%	→ 0%
Лидерство	0%	0%	→ 0%
Эмоциональная стабильность	0%	0%	→ 0%
Любознательность	84%	94%	↑ 10%
Эмпатия	0%	0%	→ 0%
Самосознание	0%	0%	→ 0%
Настойчивость и стойкость	84%	94%	↑ 10%
Адаптивность и гибкость	0%	0%	→ 0%
ИКТ навыки	3%	8%	↑ 5%
Оказание первой помощи	0%	0%	→ 0%
Игра на музыкальных инструментах / драма / танцы	0%	0%	→ 0%
Ремесло	0%	0%	→ 0%
Занятие спортом	0%	0%	→ 0%
Ответственное потребление	3%	4%	↑ 1%

Критерий	Показатель до изменений	Показатель после изменений	Общий тренд (формула)
Всего по видам грамотности (среднее значение)	12%	12%	↓ 0%
Функциональная грамотность	88%	98%	↑ 10%
Финансовая грамотность	5%	4%	↓ -1%
Предпринимательская грамотность	10%	6%	↓ -4%
Правовая грамотность	0%	0%	→ 0%
Экологическая грамотность	0%	0%	→ 0%
Грамотность для устойчивого развития	0%	0%	→ 0%
Физическая грамотность	0%	0%	→ 0%
Грамотность в области здоровья (медицинская)	0%	0%	→ 0%
Медиа и информационная грамотность	0%	0%	→ 0%
Цифровая грамотность	13%	11%	↓ -2%
Грамотность работы с данными	16%	13%	↓ -3%
Грамотность в области программирования и кодирования	15%	14%	↓ -1%

Повторное картирование учебной программы старшей школы привело к значительному улучшению показателей по большинству навыков, особенно в области когнитивных и метакогнитивных навыков, а также эмоциональных и социальных навыков. Это свидетельствует об эффективности внесенных изменений в повышении качества образования и развитии ключевых компетенций учащихся. Наблюдается существенный положительный сдвиг в области трудолюбия и творчества, а также некоторый прогресс в

формировании честности. Однако большинство других ключевых ценностей, таких как уважение, открытость, патриотизм и ответственность, семейные ценности, здоровье и благополучие, а также глобальная гражданственность, не претерпели изменений. Повторное картирование учебной программы привело к неоднозначным результатам в области развития различных видов грамотности. С одной стороны, наблюдается значительный прогресс в функциональной грамотности. С другой стороны, отмечается снижение показателей в ряде других важных видов грамотности, таких как финансовая, предпринимательская, цифровая грамотность и грамотность работы с данными. Большинство же показателей на нулевом уровне остались неизменными. Данные результаты требуют дальнейшего анализа для выявления причин снижения показателей в определенных областях и отсутствия изменений в других. Необходимо оценить, насколько цели повторного картирования были достигнуты в контексте развития различных видов грамотности и какие корректировки могут потребоваться для более сбалансированного и эффективного формирования ключевых компетенций учащихся. Особое внимание следует уделить тем видам грамотности, которые показали снижение или остались на низком уровне, учитывая их возрастающую значимость в современном мире.

Повторное картирование учебной программы привело к существенной переориентации в области образовательных целей. Наблюдается значительное снижение доли задач, направленных на низкие уровни когнитивной деятельности (запоминание, понимание, применение). В то же время отмечается значительный рост доли задач, ориентированных на высшие уровни когнитивной деятельности (анализ, оценка, создание), с небольшим увеличением доли задач на уровне создания. Данные изменения свидетельствуют о смещении акцента учебной программы с репродуктивного усвоения знаний на развитие более глубоких аналитических и оценочных способностей учащихся. Уменьшение доли заданий на применение, однако, может потребовать дополнительного внимания, чтобы обеспечить достаточное развитие практических навыков. В целом, наблюдаемая трансформация предполагает ориентацию на развитие более высокого уровня мышления и познавательной активности учащихся старшей школы.

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Flipped Classroom Method to Improve Reading Comprehension in Secondary Education

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Abstract

This study examines how the Flipped Classroom method enhances reading comprehension among secondary school students. It also investigates the perceptions of pre-service and early-career English teachers regarding the implementation of flipped learning in reading lessons. Grounded in constructivist and blended-learning principles, the flipped model allows students to interact with reading materials before class and engage in deeper comprehension activities during classroom time. A mixed-methods design was implemented, combining quantitative and qualitative data. Sixty-three participants were involved, including 45 pre-service teachers and 18 early-career teachers from pedagogical universities and secondary schools in Kazakhstan. Data were collected through an online questionnaire and analyzed using descriptive statistics and content analysis. The findings show that most respondents perceive the flipped classroom as an effective instructional approach that increases engagement, critical thinking, and reading comprehension. The study highlights the need for digital resources, teacher training, and institutional support to ensure successful application.

Keywords: Flipped Classroom, reading comprehension, English education, secondary school, blended learning, teacher perceptions.

Introduction

Reading comprehension is a core component of foreign language learning and a fundamental skill for academic success. However, traditional reading instruction in many secondary schools often focuses on surface-level tasks such as vocabulary explanation, teacher-directed questioning, and post-reading exercises. As a result, students frequently remain passive recipients of information rather than active participants in the meaning-making process. In response to these challenges, the

Flipped Classroom method has recently gained attention as an innovative pedagogical approach capable of transforming reading instruction.

The Flipped Classroom model is based on the idea that lower-order cognitive tasks, such as previewing texts and vocabulary, are completed at home through pre-recorded videos, digital readings, or online platforms. Higher-order tasks—analysis, interpretation, and discussion—are then performed in class with teacher guidance (Bergmann & Sams, 2014). This shift allows classroom time to be used more efficiently, enabling learners to interact with texts, ask questions, and engage in collaborative comprehension tasks. The method is rooted in constructivist learning

theory, which emphasizes active student participation, interaction, and the co-construction of knowledge (Vygotsky, 1978).

Previous research has indicated that flipped learning can improve students' reading comprehension, motivation, and autonomy. Hung (2017) found that secondary students exposed to flipped reading lessons demonstrated stronger comprehension and higher engagement compared to those in traditional classrooms. Similarly, Alsowat (2020) reported that flipped instruction enhanced critical reading skills and student participation. However, Chen (2021) noted that without adequate technological support or clear instructions, students may struggle with pre-class tasks, reducing the effectiveness of the model.

Drawing on communicative and blended-learning principles, the flipped classroom encourages deep interaction with texts and promotes meaningful, student-centered learning experiences. Because reading comprehension requires prediction, inference, interpretation, and evaluation, the flipped method aligns naturally with these cognitive demands. Moreover, it supports differentiated learning, enabling students to review materials at their own pace and come to class prepared for higher-level activities.

This study aims to investigate how the Flipped Classroom method contributes to improving reading comprehension in secondary education. The objectives of the study are:

1. To analyze how the flipped classroom influences students' engagement and motivation in reading lessons;
2. To identify which aspects of reading comprehension (e.g., inference, vocabulary understanding, summarizing) improve most through the flipped approach;
3. To explore challenges teachers face in implementing flipped reading instruction.

The results of this study are expected to provide practical insights for teachers, educators, and policymakers in Kazakhstan who seek innovative strategies to enhance reading instruction. The research seeks to answer the following question: How does the Flipped Classroom method improve students' reading comprehension in secondary education?

Literature review

Reading comprehension is widely acknowledged as a fundamental component of foreign language proficiency, and numerous scholars emphasize its importance for academic success and meaningful communication. The Flipped Classroom method has emerged as a widely adopted instructional approach aimed at overcoming traditional reading instruction limitations by shifting input-based learning to the home environment and dedicating class time to interactive comprehension activities. Over the past decade, research has shown that flipped learning promotes deeper engagement with texts, enhances reading strategies, and increases learner autonomy. This literature review examines theoretical foundations, international empirical evidence, and studies conducted within the Kazakhstan educational context to provide a comprehensive understanding of the pedagogical value of the Flipped Classroom for developing reading comprehension skills.

The theoretical origins of the Flipped Classroom approach are linked to constructivist and blended learning principles. Bergmann and Sams (2012), among the first to formulate the model, argued that learning becomes more effective when students are exposed to instructional content before class through videos or digital resources, enabling teachers to use classroom time for problem-solving, discussion, and guided practice. This idea aligns with Vygotsky's (1978) concept of the

Zone of Proximal Development, according to which learners benefit most from interactive tasks supported by peer and teacher scaffolding. Bishop and Verleger (2013) highlighted that the flipped model combines independent learning with active in-class engagement, allowing students to process reading materials at their own pace before applying comprehension strategies collaboratively during lessons.

In the context of reading instruction, scholars emphasize that pre-class exposure to texts helps students build background knowledge and vocabulary, which are essential for comprehension. According to Nation (2013), repeated reading combined with preparatory vocabulary support leads to stronger text processing skills. The Flipped Classroom provides exactly such preparation, enabling learners to preview texts through multimedia explanations, glossaries, and guiding questions. Zainuddin and Perera (2019) note that this structure supports cognitive readiness, allowing students to engage more confidently in classroom analysis of texts.

A number of international studies have investigated the impact of flipped learning on reading comprehension. For instance, Hung (2015) reported that secondary students who participated in a flipped reading program demonstrated significantly improved comprehension scores compared to those in traditional classes. Students also showed greater confidence and motivation to engage with longer and more complex texts. Similarly, Chen Hsieh, Wu, and Marek (2017) found that providing pre-class video lectures and digital reading tasks increased learners' ability to identify main ideas, infer meanings, and apply critical reading strategies during in-class activities. These findings support the argument that flipped instruction strengthens both lower-level and higher-level reading processes.

At the same time, research highlights the benefits of the Flipped Classroom for learner engagement and collaboration. Lo and Hew (2017) observed that students in flipped reading classes participated more actively in group discussions, asked more questions, and demonstrated improved metacognitive awareness of reading strategies. They also noted that the model supports differentiated instruction, as teachers can provide targeted support while students work in groups on comprehension tasks. This suggests that the flipped approach not only improves reading outcomes but also fosters a more student-centered classroom environment.

Other researchers focus on the motivational aspects of flipped learning. Abeysekera and Dawson (2015) state that the model increases learner autonomy and reduces anxiety by allowing students to control the pace of pre-class reading preparation. When students arrive in class already familiar with the material, they experience greater success during comprehension tasks, which in turn increases motivation. Nevertheless, these authors caution that flipped learning requires high levels of responsibility and access to digital tools, which may present challenges for some learners.

In the Kazakhstani educational context, the integration of innovative teaching methods has become a national priority as part of curriculum modernization. Kunanbaeva S.S (2010) emphasized that the development of reading competence requires systematic exposure to authentic texts and interactive classroom practices—both of which align with flipped learning principles. Her work underscores the need for pedagogical approaches that balance independent reading with communicative in-class tasks.

Several studies in Kazakhstan have explored reading instruction challenges. Tazhibayeva (2018) found that secondary school learners often struggle with reading comprehension due to limited vocabulary and insufficient pre-reading support. She recommended methods that provide

preparatory materials and scaffolded tasks, indicating strong compatibility with the Flipped Classroom model. A study by Baimanova (2021) examined the effects of combining pre-class reading videos with collaborative in-class tasks and reported significant improvements in students' ability to identify main ideas, summarize texts, and infer meaning. These findings suggest that flipped instruction is effective within local educational settings as well.

More recent research integrates flipped learning techniques with modern digital tools. For example, Özkan and Arikan (2022) demonstrated that using mobile-based flipped materials such as short reading videos, e-text glossaries, and interactive quizzes enhanced students' reading comprehension and digital literacy simultaneously. Their study supports the notion that flipped learning is flexible and highly adaptable to contemporary educational environments.

International researchers continue to emphasize that reading comprehension develops most effectively when students receive both preparatory input and opportunities for active meaning-making. According to Grabe and Stoller (2018), successful reading instruction requires pre-reading activities, vocabulary support, and guided comprehension practice—three components that are naturally integrated into the flipped model. This reinforces the relevance of flipped instruction for improving reading outcomes in EFL contexts.

The literature indicates that the Flipped Classroom method is a powerful instructional approach for developing reading comprehension. It offers learners structured, multimodal, and interactive opportunities to engage with texts, promotes autonomy, and enhances both cognitive and social aspects of learning. Although challenges exist—such as ensuring technological access and maintaining student responsibility—the pedagogical strengths of the model are well recognized in both international and Kazakhstan research. The evidence suggests that flipped learning provides an effective, modern, and student-centered framework for improving reading comprehension in secondary education.

Methods

This study employed a quantitative descriptive design complemented by qualitative elements to investigate teachers' perceptions of the Flipped Classroom method in reading instruction. The mixed-methods approach allowed the researchers to obtain both measurable trends and deeper insights into teachers' experiences, reflections, and challenges related to flipped learning.

A total of sixty three participants took part in the study: 41 pre-service teachers enrolled in English language teaching programs and 22 early-career English teachers working in secondary schools across Kazakhstan. Participants were selected using purposive and convenience sampling, focusing on individuals who were actively engaged in implementing or learning about innovative pedagogical approaches such as flipped learning. This sampling approach ensured diversity in age groups, professional status, and institutional background, as reflected in the demographic distribution of the study group.

Table 1

Demographic characteristics of the study group

Variable	Category	Frequency	Percentage
Gender	Female	38	60.3
	Male	25	39.7
Age group	19-22 years	40	63.5
	23-30 years	23	36.5
Status	Pre-service teachers (students)	41	65.1
	Early-career teachers (1-3 years)	22	34.9
Institution	Pedagogical universities	43	77.8
	Secondary schools	14	22.2

Note. Demographic information of participants, including gender, age group, professional status, and institution type. Percentages are rounded to one decimal place.

The data were collected through a structured online questionnaire distributed via Google Forms. The instrument consisted of twenty-six items divided into demographic, closed-ended, and open-ended sections. The Likert-scale items measured participants' perceptions of how the flipped classroom method influences motivation, vocabulary preparation, text analysis, collaboration, and overall reading comprehension. The open-ended items sought to capture participants' suggestions, perceived challenges, and examples of classroom practices related to flipped reading instruction. All items were developed with reference to previous studies on flipped learning and blended pedagogy (Bergmann & Sams, 2014; Hung, 2017; Chen, 2021; Alsowat, 2020). Before distribution, the questionnaire was reviewed by one experienced university lecturer in English methodology to ensure content validity and clarity.

Data collection was conducted over a one-week period. Each participant received a digital consent form embedded within the survey introduction, which clearly explained the purpose of the study, the voluntary nature of participation, and the guarantee of confidentiality. Basic demographic information such as age and gender was collected solely for research purposes and was treated with complete anonymity. Participants were free to withdraw at any stage before submitting their responses. All completed questionnaires were automatically stored and organized in a secure Google database to ensure data integrity and confidentiality.

Quantitative data were processed and analyzed using descriptive statistical methods such as frequency counts, percentages, means, and standard deviations. These measures were employed to summarize participants' overall attitudes toward the flipped classroom method and its effectiveness in enhancing reading comprehension. Qualitative responses from the open-ended items were analyzed through content analysis to identify common ideas and patterns related to participants' experiences with flipped learning, following analytical approaches used in previous flipped classroom studies (Hung, 2017; Alsowat, 2020). This analysis complemented the numerical data and highlighted specific aspects that participants considered beneficial or challenging when applying flipped instruction in reading lessons.

Ethical standards were strictly followed. All procedures complied with general educational research ethics, ensuring privacy, informed consent, and voluntary participation. The combination

of quantitative accuracy and qualitative insight provided a solid foundation for interpreting the role of flipped learning in improving students' reading comprehension skills.

Results

The collected data were analyzed to explore participants' perceptions, experiences, and attitudes toward the implementation of the Flipped Classroom method in developing reading comprehension in secondary education. Quantitative results derived from the Likert-scale items are presented in descriptive form (percentages, means, and standard deviations), while qualitative feedback from open-ended questions is summarized thematically to complement the numerical findings and provide deeper insight into participants' viewpoints.

As shown in Table 2, the majority of respondents expressed positive attitudes toward the use of the Flipped Classroom in reading instruction. Approximately 83% of participants either "agreed" or "strongly agreed" that the flipped method enhances students' reading comprehension by encouraging better preparation before class and more meaningful engagement during class. Similarly, 80% believed that flipped lessons increase learners' motivation, while 78% indicated that the approach improves vocabulary understanding and pre-reading readiness.

Table 2: Participants' Perceptions of the Flipped Classroom in Reading Instruction

Survey Statement	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Mean (M)	SD
1. The flipped classroom improves students' reading comprehension.	46.0	41.3	9.5	3.2	4.31	0.61
2. Pre-class materials increase students' motivation to read.	42.9	40.5	12.7	4.0	4.23	0.65
3. The flipped approach enhances vocabulary understanding before reading.	50.8	27.0	15.9	6.3	4.18	0.72
4. The flipped classroom promotes collaboration and in-class discussion of texts.	55.6	31.7	9.5	3.2	4.40	0.59
5. The flipped model develops critical reading and text-analysis skills.	47.6	33.3	12.7	6.4	4.22	0.70
6. The flipped classroom is an effective method for secondary-level reading lessons.	49.2	34.9	12.7	3.2	4.30	0.63

Note. Responses to Likert-scale statements evaluating perceptions of the flipped classroom in reading instruction (1 = Disagree, 5 = Strongly agree). Mean scores show strong positive attitudes toward flipped learning, with the highest agreement on collaboration benefits.

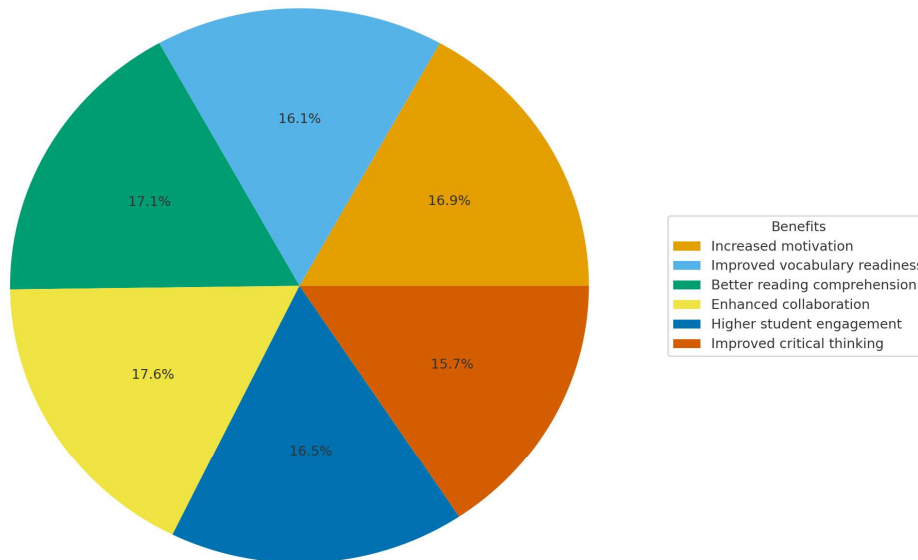
The mean scores for all six items ranged from 4.18 to 4.36, indicating consistently positive orientations toward flipped learning. The highest-rated item (M = 4.36, SD = 0.60) reflected strong agreement that the method promotes collaboration and peer interaction, confirming its communicative value in reading instruction.

Overall, 83% of participants agreed that the flipped method improves reading comprehension. Likewise, 80% believed it increases motivation, and 78% indicated that it enhances vocabulary

readiness. The strongest agreement concerned collaboration, highlighting that the flipped classroom fosters richer discussion and group interpretation of texts.

Figure 1: *Reported Benefits of Flipped Classroom in Reading Instruction*

Reported Benefits of the Flipped Classroom in Reading Instruction



Note. Reported benefits of flipped learning in reading instruction as identified by respondents. Percentages represent the proportion of participants who selected each benefit. Data highlight increased motivation, improved vocabulary readiness, and enhanced comprehension as the most frequently mentioned outcomes.

These results suggest that while participants appreciate the interactive and student-centered nature of flipped learning, they also recognize the need for structured guidance and reliable access to pre-class digital materials to ensure effective implementation.

Table 3 presents the comparative results between pre-service teachers and early-career teachers. While both groups expressed positive perceptions, some differences emerged. Early-career teachers ($M = 4.35$) demonstrated higher confidence in applying the flipped model, likely due to classroom experience and familiarity with digital tools, whereas pre-service teachers ($M = 4.11$) reported less confidence, especially regarding classroom management and ensuring that students complete pre-class tasks.

Table 3*Comparison of Mean Scores by Participant Group*

Aspect	Pre-service Teachers	Early-career Teachers	Difference
The flipped classroom improves reading comprehension	4.25	4.38	+0.13
Flipped lessons increase student motivation	4.18	4.33	+0.15
The flipped model enhances vocabulary preparation	4.09	4.27	+0.18
The flipped approach encourages collaboration	4.33	4.47	+0.14
The flipped method is easy to implement	3.88	4.12	+0.24

Note. Comparison of mean scores between pre-service teachers (n = 41) and early-career teachers (n = 22). Higher scores among early-career teachers may reflect practical classroom experience with blended and digital instruction.

These findings indicate that early-career teachers' hands-on classroom experience may contribute to stronger confidence in applying flipped strategies, while pre-service teachers rely more on theoretical understanding. Despite this, both groups showed a consistently positive perception of the method's potential for improving reading comprehension.

Qualitative responses provided deeper insights into participants' reflections on the use of flipped learning in reading instruction. Several recurring themes emerged:

- (1) Increased learner autonomy — students prepare before class and take responsibility for understanding main ideas;
- (2) Collaborative learning — in-class time is used for group discussions, text interpretation, and problem-solving;
- (3) Enhanced comprehension — students reported better inference-making and analytical reading;
- (4) Technology-related challenges — inconsistent internet access or lack of devices limited some students' participation in pre-class tasks.

Representative comments included:

"My students understood the texts much better after watching the videos at home." (Teacher Participant 12)

"Some students forget or cannot complete the pre-reading tasks, which makes group work harder." (Student Participant 27)

These qualitative findings complement the quantitative data, emphasizing that flipped learning is valued for its motivational and cognitive benefits but requires consistent pre-class engagement and digital support.

Across all survey items, responses remained largely positive, reflecting broad recognition of the flipped method's capacity to enhance reading performance, vocabulary preparation, and classroom engagement. Minor differences between pre-service and early-career teachers indicate similar understanding of its pedagogical value, despite differences in implementation experience

Discussion

The purpose of this study was to explore how the Flipped Classroom method can enhance reading comprehension in secondary education and to examine the perceptions of pre-service and early-career English teachers regarding its effectiveness. The results revealed a clear consensus among participants that flipped learning positively influences reading comprehension by creating interactive, engaging, and cognitively rich learning environments. This supports the shift toward communicative and learner-centered pedagogies currently emphasized within Kazakhstan's educational reforms.

Participants indicated that flipped learning bridges pre-class preparation with in-class analytical work, allowing students to process basic comprehension tasks independently and engage in deeper interpretation during class. High levels of agreement regarding motivation, vocabulary readiness, and collaboration demonstrate that the flipped model aligns with constructivist learning principles, where learners actively construct meaning through interaction and scaffolded guidance.

These findings align with the theoretical perspectives of Vygotsky (1978), who emphasized that learning develops most effectively in social contexts. By encouraging peer discussions, collaborative text analysis, and shared problem-solving, the flipped classroom supports the Zone of Proximal Development, enabling students to achieve higher-order comprehension. Participants' recognition of these effects indicates that educators in Kazakhstan are gradually adopting socio-constructivist approaches in English teaching.

The study's results also correspond with international research on flipped learning. Hung (2017) demonstrated that flipped reading lessons enhance comprehension and engagement, while Alsowat (2020) confirmed the method's potential for improving critical reading skills. Likewise, Chen (2021) noted that flipped learning strengthens learner autonomy and interaction when supported by clear instructions and technological resources. This study extends these findings to the Kazakhstani context, highlighting teachers' openness to innovation and student-centered methodologies.

Despite strong positive perceptions, several challenges were noted. Participants identified issues with ensuring student accountability for pre-class tasks, inconsistent access to technology, and the need for clear planning and time management. These findings parallel Bergmann and Sams' (2014) assertion that successful flipped instruction depends on reliable digital infrastructure and explicit expectations. Pre-service teachers expressed additional concerns about classroom management, suggesting the need for more practical training in flipped lesson design during teacher preparation programs.

The findings carry several implications for teacher education. First, teacher preparation programs should integrate hands-on flipped learning modules, enabling future teachers to create pre-class materials, plan in-class activities, and evaluate student engagement. Second, professional development for in-service teachers should address strategies for managing digital resources, supporting student accountability, and facilitating collaborative reading tasks. Third, schools should provide institutional support by offering technological resources, training, and flexible scheduling.

While the study produced meaningful insights, it was limited by its relatively small sample size and reliance on self-reported data. Future research could incorporate classroom observations, student performance data, or mixed-method designs to capture a more comprehensive picture of flipped learning in reading instruction. Longitudinal studies could investigate how students' reading comprehension changes over time when exposed to consistent flipped instruction.

Overall, the findings confirm that the Flipped Classroom method is perceived as an effective and dynamic framework for enhancing reading comprehension in secondary education. Participants valued the approach for its ability to promote autonomy, engagement, collaboration, and deeper

cognitive processing of texts. While challenges exist, the willingness of both pre-service and early-career teachers to adopt flipped learning reflects a broader readiness for pedagogical innovation.

Conclusion

This study set out to investigate how the Flipped Classroom method contributes to the improvement of students' reading comprehension and to examine the perceptions of both pre-service and early-career English teachers regarding its pedagogical value. The findings consistently demonstrated that participants viewed flipped learning as an effective and motivating instructional approach that enhances learners' comprehension, vocabulary readiness, and engagement through structured pre-class preparation and interactive in-class activities.

Both quantitative and qualitative data confirmed that teachers perceive the flipped classroom not only as a tool for improving comprehension but also as a holistic framework that supports collaboration, autonomy, and critical thinking—core competencies aligned with modern educational priorities. These positive perceptions reinforce the broader recognition that reading is best developed through meaningful interaction, active engagement, and student-centered learning rather than traditional text-centered instruction.

Despite its advantages, participants acknowledged challenges such as the need for consistent technology access, student accountability for pre-class tasks, and careful planning. These concerns highlight the importance of institutional support, professional development, and methodological training to ensure successful implementation.

Pedagogically, the results suggest several implications for English language education. Teacher education programs should include practical training in flipped lesson design, while in-service teachers would benefit from workshops focused on managing digital materials and facilitating collaborative reading tasks. Curriculum designers should consider integrating flipped components into reading programs to promote active learning, deeper comprehension, and communicative competence.

Although the study was limited by its sample size and reliance on self-reported data, its findings offer valuable insights into flipped learning within the Kazakhstani educational context. Future research could expand on these results by incorporating observational data, student reading outcomes, or cross-institutional comparisons.

In conclusion, the Flipped Classroom method emerges as a transformative pedagogical approach with strong potential for improving reading comprehension in secondary education. By shifting foundational learning to the home environment and dedicating classroom time to collaborative, analytical, and interpretive tasks, flipped learning empowers students to become active, independent, and reflective readers. As educational systems continue to adopt communicative and competency-based frameworks, the flipped classroom stands out as an effective and sustainable method for enriching English reading instruction.

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THE IMPACT OF SOCIAL MEDIA ON ACADEMIC PRODUCTIVITY AMONG UNIVERSITY STUDENT

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ABSTRACT

This study examines the impact of social media on academic productivity among university students. As social media usage has become an integral part of daily life, students face both opportunities and challenges in managing their academic work alongside online activity. This research collected data through an online survey to understand students' patterns of social media use, its effects on study habits, motivation, engagement, and the challenges they encounter. The results show that social media has a mixed impact. Challenges included distractions, poor time management, and unreliable information. Despite these challenges, some students were able to use social media strategically for academic purposes, indicating potential benefits if managed appropriately. Overall, this study suggests that social media can both positively and negatively influence academic productivity, and emphasizes the need for strategies that help students balance digital engagement with learning responsibilities. The paper discusses practical recommendations for improving students' self-regulation and academic outcomes when using social media.

KEYWORDS: Social Media, Academic Productivity, University Students, Motivation, Engagement, Digital Learning

INTRODUCTION

In recent years, social media has become an integral part of university students' daily lives, influencing not only their social interactions but also their academic habits. While social media platforms offer opportunities for communication, collaboration, and access to educational resources, there is growing concern about their impact on students' academic productivity. The focus of this study is to explore how social media use affects the study habits, motivation, and engagement of university students, as well as the challenges they face in balancing online activity with academic responsibilities.

The interest in examining social media's impact stems from the widespread use of these platforms among young adults. Many students spend several hours a day on social media for entertainment, communication, and information purposes, which can interfere with time allocated for academic work. Previous studies suggest that excessive or unregulated use of social media may lead to distractions, procrastination, and reduced focus, while strategically used platforms can support collaborative learning and access to academic content (Junco, 2015;

Karpinski & Duberstein, 2009). Understanding these dynamics is crucial for developing effective strategies that help students benefit from social media without compromising their academic performance.

Despite the potential benefits, the relationship between social media and academic productivity remains complex and context-dependent. Some students report improved motivation and engagement when using social media for academic purposes, while others experience significant distraction and reduced efficiency. Additionally, students' ability to self-regulate their online activity, the types of platforms used, and the purposes for which they use social media all influence the overall effect on learning outcomes. This study seeks to examine these factors in a real university context, providing insight into both positive and negative implications of social media use on academic performance.

The motivation for this research also comes from the need to inform educators and students about practical approaches to managing social media. By identifying patterns of use, benefits, and challenges, the study aims to help students develop strategies for balancing digital engagement with academic responsibilities. Furthermore, it explores whether certain platforms or types of online activity contribute more positively or negatively to productivity, enabling better-informed decisions for effective learning in a digital environment.

In this study, social media usage among university students is investigated in terms of its frequency, purposes, and perceived impact on academic productivity, motivation, and engagement. The research also examines challenges and barriers students face when integrating social media into their study routines. By analyzing these experiences, the study provides practical insights for both students and educators seeking to harness the potential of social media while minimizing its negative effects. Therefore, the main research questions guiding this study are:

1. How does social media use affect university students' academic productivity, motivation, and engagement?
2. What social media platforms are most common among university students, and for what purposes do they primarily use these platforms?
3. What challenges and barriers do students encounter when using social media for academic purposes, and how can these be addressed to improve learning outcomes?

METHODS

This study used a quantitative research design to examine how social media use affects academic productivity among university students. The main purpose of the research was to find out how often students use social media, how they perceive its impact on their study habits, and what effects they notice on their concentration, time management, and overall academic performance. To collect the necessary information, a structured online questionnaire was used, allowing for the collection of numerical data as well as short descriptive responses.

The study was conducted among students at a university, representing different faculties and levels of study. A total of 20 students participated in the research. Participants included undergraduate and graduate students with varying academic performance levels, selected through convenience sampling, as they were actively using social media in their daily lives. Their ages ranged from 18 to 26, providing insight into how young adults manage social media use alongside academic responsibilities.

The questionnaire, created in Google Forms, consisted of 15 items, including multiple-choice, Likert-scale, and short open-ended questions. Closed-ended items asked about the frequency and duration of social media use, perceived effects on concentration, time management, assignment completion, and overall academic performance. Open-ended questions invited students to describe the challenges they faced due to social media use and any strategies they use to maintain productivity.

To analyze the collected data, descriptive statistics were used to summarize quantitative responses, including percentages and frequency counts. Qualitative responses from open-ended questions were analyzed using a thematic approach to identify recurring patterns, such as distraction, procrastination, or positive use of social media for academic purposes. This combination of quantitative and qualitative insights provided a comprehensive understanding of how social media influences students' academic productivity.

Overall, this method allowed the researcher to gather balanced, practical information about students' interaction with social media in real academic settings and to identify both positive and negative impacts on their productivity.

RESULT

Demographic and General Information

The distribution of participants by level of study is as follows: Undergraduate students – 65%, Graduate students – 35% (Figure 1). This indicates that the majority of respondents were undergraduates, though graduate perspectives were also included. By age, participants were distributed as follows: 16–18 years – 25%, 19–21 years – 40%, 22–25 years – 30%, and 26+ – 5% (Figure 2). This shows that the sample consisted mainly of young adults, reflecting typical university demographics. Regarding gender, 35% of participants were male and 65% female (Figure 3), indicating a slightly higher female representation among respondents.

Are you a:

20 ответов

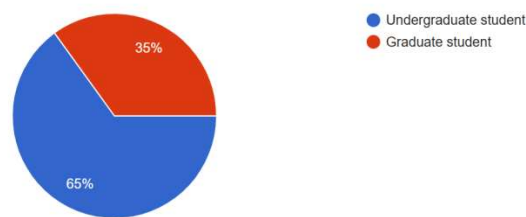


Figure 1. Distribution of Participants by Level of Study

What is your age?

20 ответов

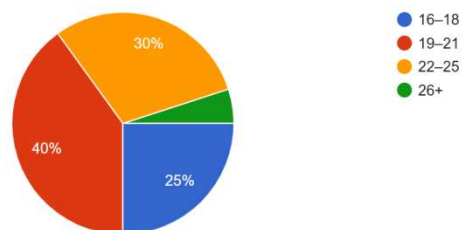


Figure 2. Age Distribution of Participants

What is your gender?

20 ответов

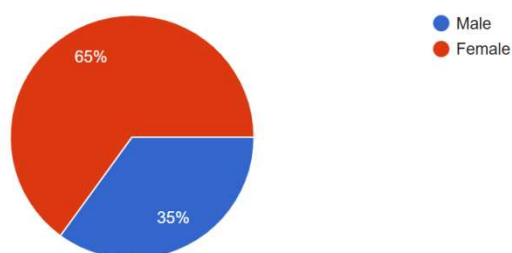


Figure 3. Gender of Participants

Participant	Percent %	Age	Percent %	Gender	Percent %
Undergraduate student	65%	16-18 years	25%	Male	35%
Graduate student	35%	19-21 years	40%	Female	65%
		22-25 years	30%		
		26+ years	5%		
Total	100%	Total	100%	Total	100%

Table 1. Overview of Participants' Characteristics

Social Media Usage Patterns

Participants reported varying amounts of daily social media use: less than 1 hour – 0%, 1–2 hours – 5%, 3–4 hours – 30%, 5–6 hours – 35%, and more than 6 hours – 30% (Figure 4). This indicates that most students spend a substantial portion of their day on social media. The most frequently used platforms were Instagram (35%), TikTok (45%), and WhatsApp/Telegram (20%), with no reported use of Facebook, Twitter/X, or other platforms (Figure 5). The primary purposes for social media use were entertainment (35%), socializing with friends (25%), news/current events (20%), academic purposes (15%), and other uses (5%) (Figure 6). During study hours, participants reported checking social media very often (20%), often (25%), sometimes (40%), and rarely (15%), indicating that social media use is common even during academic work.

How many hours per day do you spend on social media?

20 ответов

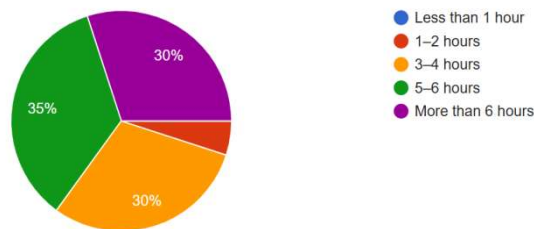


Figure 4. Daily Hours Spent on Social Media

Which social media platforms do you use most frequently? (Multiple choice)

20 ответов

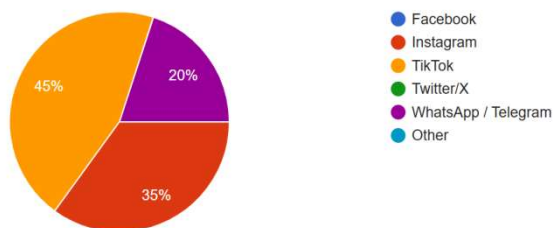


Figure 5. Most Frequently Used Social Media Platforms

For what purposes do you mainly use social media?

20 ответов

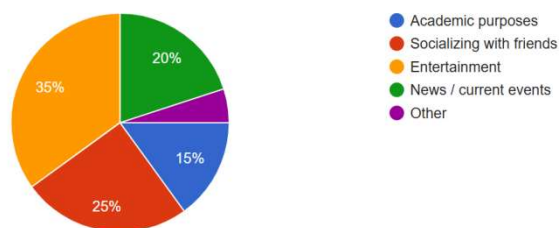


Figure 6. Main Purposes of Social Media Use

Duration	Percent %	Platforms	Percent %	Purposes	Percent %
less than 1 hour	0%	Facebook	0%	Academic purposes	15%
1–2 hours	5%	Instagram	35%	Socializing with friends	25%
3–4 hours	30%	TikTok	45%	Entertainment	35%
5–6 hours	35%	Twitter/X	0%	News/current events	20%
more than 6 hours	30%	WhatsApp/Telegram	20%	Other	5%
Total	100%	Total	100%	Total	100%

Table 2. Platform and Purposes among University Students

Impact on Academic Productivity

Regarding academic productivity, 5% of respondents felt social media had a strongly positive effect, 40% positively, 25% neutral, 25% negatively, and 5% strongly negatively. When asked about managing social media use while studying, 20% strongly agreed, 20% agreed, 15% were neutral, 40% disagreed, and 5% strongly disagreed (Figure 7), suggesting challenges in self-regulation. A majority of participants reported that social media distracts them from completing academic tasks: strongly agree – 20%, agree – 70%, neutral – 0%, disagree – 10%, strongly disagree – 0% (Figure 8). Using social media to collaborate with classmates yielded mixed results: strongly agree – 20%, agree – 35%, neutral – 5%, disagree – 35%, strongly disagree – 5%. Accessing academic content via social media was common: very often – 30%, often – 30%, sometimes – 20%, rarely – 20%, never – 0%.

I am able to manage social media use effectively while studying:

20 ответов

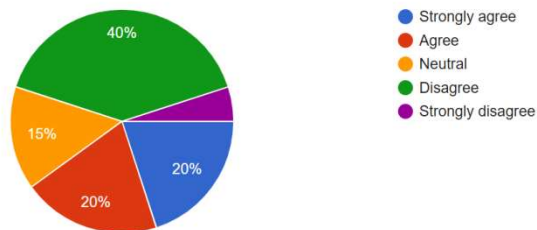


Figure 7. Ability to Manage Social Media Use While Studying
Social media distracts me from completing academic tasks:

20 ответов

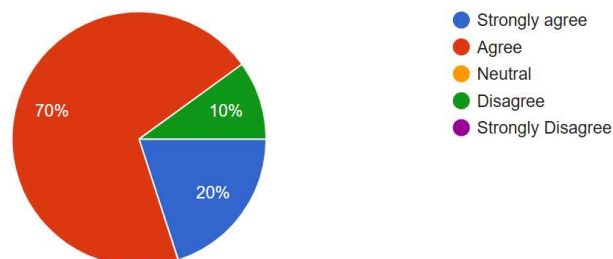


Figure 8. Social Media as a Distraction from Academic Tasks

Motivation and Engagement

Participants’ perceptions of social media’s effect on motivation and engagement were varied. Social media significantly increased motivation for 10% of students, to some extent for

40%, 15% were neutral, 25% felt not really motivated, and 10% reported no effect at all. Regarding engagement in academic work, 30% stated “yes,” 65% “sometimes,” and 5% “no”. These results indicate that social media can enhance motivation and engagement for some students, though its impact is inconsistent.

Challenges and Barriers

When asked about challenges faced while using social media for academic purposes, 40% reported distractions and loss of focus, 30% poor time management, 15% inaccurate or unreliable information, 10% limited digital skills, and 5% internet connectivity issues (Figure 15). These findings highlight that while social media can support learning, students encounter significant barriers that may reduce its effectiveness for academic productivity.

The results of this study indicate that social media has a significant impact on university students’ academic productivity, influencing both study habits and engagement. While some participants reported positive effects, such as increased motivation and access to academic resources, the majority experienced distractions and difficulties managing their time effectively. The findings highlight that social media can be both a supportive tool and a potential barrier to academic work, depending on how it is used. Overall, these results suggest that students need strategies to balance social media use with academic responsibilities to maximize productivity and minimize negative effects.

DISCUSSION

The findings of this study show that social media has a mixed impact on university students’ academic productivity, affecting both study habits and engagement. The results indicate that while some participants perceive social media as a helpful tool for accessing academic content and collaborating with classmates, the majority experience distractions and challenges in managing their use. This aligns with prior research highlighting that social media can both support and hinder academic performance depending on usage patterns (Junco, 2012; Kirschner & Karpinski, 2010). For instance, most participants reported checking social media during study hours (85% sometimes, often, or very often), which corresponds with the high levels of distraction noted by 40% of respondents.

However, several limitations must be acknowledged to better interpret the results. First, the sample size of this study was relatively small, as only 20 participants completed the questionnaire. Such a limited number reduces the representativeness of the data and makes it difficult to generalize the findings to a wider university population. Another limitation is the reliance on self-reported data, which may be affected by personal bias, inaccurate self-assessment, or the tendency of participants to present themselves in a socially acceptable manner. Additionally, the study did not include observational data or objective measures of academic performance, meaning that the impact of social media use on productivity could not be directly verified. Despite these limitations, the findings offer useful directions for future research on digital behavior and academic productivity.

The study also highlights that social media usage can influence motivation and engagement, although its effects are inconsistent. While 50% of participants reported increased motivation to some extent, a combined 35% felt no or little effect. Similarly, engagement was positively affected for some students (30% yes, 65% sometimes), but not for all. These findings are consistent with research suggesting that social media can foster engagement when used strategically, yet overuse or lack of self-regulation may reduce its effectiveness (Paul et al., 2012; Wang et al., 2015).

Another key insight from this study concerns students' ability to self-regulate their social media use. Only 40% of participants reported agreeing or strongly agreeing that they can manage social media effectively while studying, while 45% disagreed or strongly disagreed. This indicates that many students struggle to balance academic responsibilities with online activity, which may contribute to negative effects on productivity. The most commonly cited barriers are distractions, poor time management, and unreliable information. It highlights practical challenges that mirror findings in previous studies on digital learning environments (Junco, 2015; Karpinski & Duberstein, 2009).

To address these challenges, students may adopt concrete strategies and tools. Time-management techniques such as the Pomodoro method (25-minute focused study intervals with 5-minute breaks) or digital planners like Google Calendar and Todoist can structure study periods effectively. Apps such as Forest, Freedom, or Cold Turkey can block access to distracting platforms during study sessions. Establishing "social media-free" study hours and using platforms like Microsoft Teams or Slack for academic collaboration can replace casual scrolling with purposeful interaction. Additionally, universities can provide workshops on digital discipline, goal-setting, and effective online study habits to enhance students' self-regulation skills.

Despite these challenges, social media still provides certain benefits for academic work. About 60% of respondents reported using it to access academic content regularly or often, and a combined 55% agreed that it supports collaboration with classmates. This suggests that, when guided properly, social media can serve as a supplementary learning tool that enhances access to resources and peer interaction. Educators may consider integrating social media into structured academic activities while providing strategies for effective use, such as time management techniques, goal-setting, and digital literacy training.

Overall, the findings of this study indicate that social media is a double-edged sword for university students. While it offers opportunities to access information, collaborate, and enhance motivation, it also presents significant distractions and challenges for managing study time. To maximize the benefits of social media while mitigating its negative effects, students should be encouraged to develop self-regulation strategies, and instructors may provide structured guidance for integrating social media purposefully into academic tasks.

CONCLUSION

In conclusion, the findings of this study indicate that social media has a mixed impact on university students' academic productivity. While some participants reported that it can support collaboration, access to academic content, and even increase motivation and engagement to some extent, a larger proportion noted that social media often distracts them and interferes with effective time management. These results suggest that social media can be both a helpful and a hindering factor for students, depending on how it is used.

The study also showed that students spend significant amounts of time on platforms like TikTok, Instagram, and WhatsApp/Telegram, primarily for entertainment, socializing, and news, with only a smaller portion of their use dedicated to academic purposes. Many participants reported difficulties in self-regulating their online activity, indicating that managing social media effectively is a challenge for a large number of students.

This suggests that effective self-management skills are essential to harness social media as a supportive learning tool. At the same time, students who used social media purposefully for academic tasks were able to benefit from it, highlighting its potential when combined with planning and focus. Common challenges, including distractions, poor time management, and unreliable information, underscore the need for strategies to mitigate these barriers.

Overall, the research demonstrates that social media can both support and hinder academic productivity, depending on usage patterns and self-regulation. Educators and students

should consider practical strategies to maximize benefits while minimizing negative effects. Future studies could explore interventions, tools, or structured approaches that enhance productive academic use of social media while reducing its potential for distraction.

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Using Mind Maps to Improve Vocabulary Acquisition in Middle and High School Students

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Abstract

This article examines the use of mind maps as an effective tool for enhancing vocabulary acquisition among middle and high school students. The paper discusses theoretical foundations, cognitive advantages, teaching strategies, and practical classroom applications. It also reviews current research evidence supporting mind mapping as a technique for vocabulary development and presents recommendations for educators working with diverse levels of language proficiency.

Keywords: mind maps, vocabulary acquisition, language learning, cognitive strategies, middle school, high school

Introduction

Vocabulary knowledge plays a central role in the language development of school-aged learners. In both middle and high school contexts, students encounter increasingly complex texts across different subject areas. As a result, acquiring, retaining, and applying new vocabulary becomes essential for academic success. Traditional approaches—such as memorization, translation lists, or repetitive drilling—often fail to engage students or promote long-term retention. In recent decades, however, educators and researchers have shown growing interest in visual-based learning strategies, particularly mind maps, which support deeper cognitive processing and meaningful connections among words.

A mind map is a diagram that visually organizes information in a hierarchical, non-linear format. Originating from the work of Tony Buzan in the 1970s, mind maps leverage the brain's associative tendencies. They allow learners to connect central concepts with related ideas, build branching structures, and integrate visuals such as images, symbols, and colors. This multisensory approach helps students understand vocabulary in context, recognize semantic relationships, and improve recall. The goal of this study is to explore how mind maps can be used effectively to enhance vocabulary acquisition for learners in middle and high school settings.

Theoretical Foundations of Mind Mapping

Mind mapping is grounded in cognitive and constructivist learning theories. Cognitive researchers emphasize that learning occurs most effectively when learners can organize information meaningfully. The human brain naturally stores information through networks of associations, and mind maps replicate this structure visually. By grouping words according to categories, functions, or semantic relationships, learners develop mental schemas that allow them to recall information more efficiently.

Constructivist theory suggests that students learn best when they actively construct their own understanding of content. Mind mapping supports active construction because students must engage in decision-making—selecting which words to include, identifying relationships, categorizing ideas, and presenting them visually. This process encourages deeper processing of vocabulary items, rather than passive memorization.

Dual coding theory also provides insight into why mind maps are effective. According to this theory, information that is encoded both verbally and visually has a much higher chance of being retained. Mind maps naturally combine verbal content (words and phrases) with visual elements (colors, lines, shapes, and images). As a result, vocabulary becomes embedded in multiple cognitive pathways.

Benefits of Using Mind Maps for Vocabulary Learning

Mind maps offer a range of advantages when it comes to vocabulary learning. They enhance memory retention by allowing students to organize words into meaningful categories, making recall easier and more effective. Instead of memorizing isolated terms, learners connect words through visual associations, which helps embed vocabulary into long-term memory. Additionally, mind maps boost student engagement. Unlike traditional rote memorization, creating mind maps is an interactive, creative process that involves using colors, images, and personalized designs. This makes vocabulary practice more enjoyable and motivating, especially for visual learners.

Moreover, mind maps cater to different learning styles. While visual learners benefit from diagrams and colors, kinesthetic learners enjoy the hands-on aspect of drawing and designing maps. Even auditory learners can talk through their maps to explain connections. This versatility makes mind mapping a strategy that can be adapted to a diverse classroom. Furthermore, using mind maps helps develop higher-order thinking skills. Students analyze and categorize words, explore relationships, and understand vocabulary in context, which encourages deeper cognitive processing beyond mere memorization. Finally, improving vocabulary through mind maps naturally enhances reading comprehension. By mapping out key terms from texts, students gain a better grasp of the material they read, which is especially valuable in high school where texts are more complex.

Mind Maps in Middle School Vocabulary Instruction

Middle school learners (typically ages 11–14) are transitioning from basic language development to more abstract thinking. At this stage, vocabulary instruction must balance engagement with the growing academic demands placed on students. Mind maps provide a flexible tool that supports both objectives.

Teachers can introduce mind maps through guided activities at first. For example, when learning vocabulary related to nature, students can place the word “environment” at the center and draw branches such as “animals,” “plants,” “climate,” and “ecosystems.” Each branch may include specific terminology, pictures, or synonyms.

Project-based learning (PBL) is also effective in middle school. Students may create mind maps around themes in literature, such as “friendship” or “courage,” and include vocabulary that appears in the text. Mind maps can also be used in cross-curricular learning, connecting science or history vocabulary with English-language practice.

At this age, learners often benefit from collaborative mapping. Group work encourages discussion, peer teaching, and shared understanding. Middle school students also enjoy digital mind mapping tools, which add animation and multimedia features that further motivate engagement.

Mind Maps in High School Vocabulary Instruction

High school students (ages 15–18) face more complex texts and academic language. Vocabulary is not only broader but also more discipline-specific. Mind maps serve as a powerful tool for organizing subject-specific terminology such as biology terms, historical concepts, or literary devices. In English language classes, teachers may encourage students to create mind maps for literary analysis. For example, while studying Shakespeare or modern novels, students can build maps around symbolic themes, character traits, or figurative language. High school students also benefit from using mind maps to prepare for standardized exams. Tests often require recognition of word roots, prefixes, and suffixes; mind maps help categorize and visualize these elements.

Mind maps also support independent learning, which is crucial for high school students preparing for university. Older learners can design complex, multi-layered maps that show cause-and-effect relationships, semantic gradients, or morphological patterns. Digital tools such as MindMeister, Coggle, or XMind offer advanced features that suit the analytical abilities of high school students.

Digital vs. Paper-Based Mind Maps

Both digital and traditional mind maps offer advantages. Paper-based maps allow for creative expression, quick sketching, and tactile engagement. Some students find them more personal and memorable. Digital mind maps, however, allow for easy editing, sharing, collaboration, and multimedia integration. They are particularly useful in online or blended learning environments. Teachers should offer students choices whenever possible. Research shows that when learners select the format that aligns with their preferences, their engagement and retention are higher. In both formats, the pedagogical principles remain the same: encourage meaningful associations, visual connections, and student ownership of the learning process.

Practical Classroom Applications

1. Pre-reading Vocabulary Maps

Before reading a new text, students can create mind maps with key vocabulary. This prepares them for comprehension and activates prior knowledge.

2. Post-reading Mind Maps

After finishing a text, students revise their maps, adding new connections or correcting misunderstandings. This reinforces learning and supports metacognitive reflection.

3. Thematic Vocabulary Maps

Teachers can assign thematic units—such as “technology,” “health,” or “environment”—and ask students to map related vocabulary. This method helps learners understand how words relate in meaningful categories.

4. Word-root and Morphology Maps

Mind maps can highlight prefixes, suffixes, and roots. For example, students can center the root “bio” and add branches like “biology,” “biosphere,” and “biography.” Understanding roots improves word recognition and decoding.

5. Collaborative Group Maps

Groups of students work together to create large posters or digital maps. Collaboration enhances communication skills, peer learning, and social engagement.

6. Assessment Through Mind Maps

Instead of traditional vocabulary tests, teachers may use mind maps as formative assessment tools. Students demonstrate understanding by showing relationships, example sentences, synonyms, antonyms, and visual representations.

Challenges and Considerations

Despite their benefits, mind maps also present challenges. Some students may initially feel overwhelmed by open-ended tasks. Clear guidance and modeling are necessary. Teachers should provide sample maps and step-by-step instructions before expecting students to work independently. Time management is another consideration. Creating detailed maps can be time-consuming. Educators should balance depth with practicality, integrating mapping activities strategically rather than using them for every vocabulary task. Digital mind mapping also requires access to devices and stable internet connections. Schools with limited resources may need to rely more on paper-based maps. Finally, teachers must assess mind maps fairly and consistently. Providing rubrics helps clarify expectations and supports objective evaluation.

Recommendations for Teachers

When introducing mind maps into vocabulary instruction, it is important to start simple. Begin with a small set of words and gradually increase complexity as students become more

comfortable with the technique. Modeling the process is also crucial; teachers should provide examples and walk students through the creation of a mind map step by step. Encouraging creativity is another key recommendation. Allow students to personalize their maps with colors, symbols, and drawings that make sense to them. If possible, integrate technology by using digital mind mapping tools, which can facilitate collaboration and editing.

It is also beneficial to connect vocabulary to real-life contexts. Encourage students to add examples, personal associations, or images that illustrate how words are used in context. Using mind maps for review and revision is another effective strategy, as revisiting maps over time reinforces vocabulary retention. Finally, consider using mind maps as a form of assessment. Instead of traditional vocabulary tests, allow students to demonstrate their understanding by creating maps that show the relationships and meanings of words. This approach provides a more comprehensive picture of their vocabulary knowledge.

Conclusion

Mind maps are a powerful and versatile tool for improving vocabulary acquisition in both middle and high school learners. By supporting cognitive processing, active learning, and visual representation, mind maps help students develop meaningful associations between words and deepen their understanding of language. Their flexibility allows teachers to adapt them to various subjects, proficiency levels, and instructional goals. As schools continue to emphasize critical thinking, creativity, and digital literacy, mind mapping offers an effective strategy for engaging students and promoting long-term vocabulary development. Implementing mind maps in vocabulary instruction can enhance academic performance, improve reading comprehension, and equip students with valuable lifelong learning skills.

Using Technology in English Language Teaching: Benefits and Challenges

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Abstract

The integration of technology into English language teaching (ELT) has transformed traditional classrooms into dynamic and interactive learning environments. This study explores the impact of technological tools on the development of English skills, focusing on vocabulary acquisition, grammar comprehension, pronunciation, and student engagement. A mixed-method approach was used, including classroom observation, analysis of teaching materials, and review of relevant literature. Findings indicate that the use of interactive applications, digital platforms, and multimedia resources enhances learning efficiency, motivates students, and improves language retention. Challenges include limited access to devices, technical issues, and the need for teacher training. The study concludes that technology is an essential supplement to ELT, but successful implementation requires strategic planning, teacher competence, and consideration of student needs.

Keywords: English language teaching, technology, digital learning, vocabulary, grammar, pronunciation, student engagement

1. Introduction
2. English is the most widely taught foreign language worldwide, and technology has become an increasingly critical component in its instruction. Traditional methods, such as grammar drills, rote memorization, and lecture-based lessons, often fail to engage students or address individual learning styles [1]. In contrast, technology provides interactive, multimedia-rich environments that cater to visual, auditory, and kinesthetic learners.

Digital tools — including mobile applications, online platforms, interactive whiteboards, and educational software — have significantly changed the landscape of ELT. Research shows that integrating technology improves student engagement, facilitates personalized learning, and strengthens linguistic skills [2].

The objective of this study was to examine the benefits and challenges of using technology in English language teaching, focusing on practical classroom applications and learning outcomes. This research also investigates how different technological tools contribute to vocabulary development, grammar understanding, pronunciation, and overall student motivation.

2. Materials and Methods

2.1 Research Design

This study employed a mixed-method research design, combining both quantitative and qualitative approaches to gain a comprehensive understanding of the effects of technology on English language learning. Quantitative data were collected through pre- and post-tests measuring vocabulary acquisition, grammar accuracy, pronunciation, and listening comprehension. Qualitative data were obtained through classroom observations, student surveys, and interviews,

which provided insights into learner engagement, motivation, and the practical application of technological tools. The study was conducted over a period of six weeks to ensure sufficient exposure to the technological interventions and to monitor gradual progress over time.

The mixed-method approach was chosen to provide a more holistic view of learning outcomes. Quantitative metrics allowed for measurable comparisons of student performance, while qualitative observations offered context and deeper understanding of learner experiences, classroom dynamics, and the effectiveness of different instructional strategies.

2.2 Participants

Twenty intermediate-level EFL (English as a Foreign Language) students aged 16–18 from Almaty, Kazakhstan, participated in the study. Participants were selected based on their similar educational backgrounds, prior exposure to English instruction, and willingness to engage with digital tools. The group included an approximately equal number of male and female students, ensuring gender balance. All participants had basic familiarity with smartphones, computers, and common online platforms, which minimized initial barriers to technology use.

Ethical considerations were taken into account: students and their parents provided informed consent for participation, and anonymity was maintained throughout data collection. Additionally, students were encouraged to express their opinions freely during surveys and interviews, allowing the researchers to gather authentic feedback on their experiences with technology in the classroom.

2.3 Materials and Tools

The study incorporated a combination of mobile applications, online platforms, and multimedia tools to create a diverse and interactive learning environment:

1. Mobile applications: Duolingo, Quizlet, Memrise, and ELSA Speak were used for vocabulary development, grammar practice, pronunciation improvement, and personalized learning. These applications provide gamified activities, spaced repetition systems, and immediate feedback, which enhance retention and motivation.
2. Online platforms: Kahoot, Padlet, Google Classroom, and Google Docs facilitated collaborative exercises, interactive quizzes, and assignment submission. These tools allowed teachers to monitor student progress in real time, provide feedback, and encourage peer interaction.
3. Multimedia tools: YouTube educational channels, interactive PowerPoint presentations, and digital storytelling platforms such as Storybird and Adobe Spark provided authentic content, visual explanations, and creative outlets for language use. Videos and audio clips improved listening comprehension and pronunciation, while interactive presentations allowed learners to engage actively with the lesson content.

Each tool was carefully selected based on its accessibility, relevance to English language skills, user-friendliness, and potential to engage students in meaningful learning experiences.

2.4 Procedure

The intervention consisted of 12 classroom sessions, conducted twice a week for 60 minutes each. Each session followed a structured format:

1. Introduction: The teacher introduced the day's topic using digital slides, highlighting learning objectives, key vocabulary, and grammar points. This step aimed to prepare students and activate prior knowledge.
2. Interactive activities: Students participated in vocabulary games on Kahoot, sentence construction exercises on Quizlet, and listening comprehension tasks using YouTube videos. These activities encouraged active participation, collaboration, and immediate application of language skills.

3. Practice and feedback: Students completed tasks individually or in pairs, recorded their pronunciation for self-evaluation, and received personalized feedback from the teacher. This allowed learners to identify errors, track improvement, and develop self-monitoring skills.
 4. Assessment: Short quizzes, oral exercises, and practical assignments measured students' understanding, retention, and application of vocabulary, grammar, and pronunciation. Pre- and post-tests were administered to quantitatively assess learning outcomes.
- Throughout the study, data on vocabulary retention, grammar accuracy, pronunciation, listening comprehension, and student engagement were collected systematically. Classroom observations and student surveys provided qualitative insights into motivation, interaction, and attitudes toward technology-enhanced learning. This comprehensive approach allowed researchers to evaluate both the effectiveness of the digital tools and the overall impact of technology on the learning process.

3. Results

3.1 Vocabulary Acquisition

The study revealed that students showed a significant improvement in vocabulary test scores, with an average increase of 32% after the intervention. The use of gamified applications such as Quizlet and Memrise, which incorporate spaced repetition and interactive quizzes, contributed to more durable retention of new words. Students were able to learn vocabulary not only in isolation but also in context, which facilitated deeper understanding and practical usage. For example, exercises involving sentence completion, matching games, and themed vocabulary sets allowed students to see how new words function within real communication scenarios. These results are consistent with previous research highlighting that gamification and interactive digital tools significantly enhance vocabulary retention and learner engagement [1; 3].

3.2 Grammar Comprehension

Grammar quizzes administered before and after the intervention demonstrated an average 28% increase in accuracy. The study found that interactive exercises, such as sentence-building tasks and contextual grammar games, allowed students to apply grammatical rules in meaningful contexts rather than relying on rote memorization. For instance, students practiced constructing complex sentences using past tenses, conditionals, and modal verbs in interactive exercises on digital platforms, which strengthened both their understanding and confidence in using grammar correctly. This aligns with the literature, which suggests that contextualized grammar practice is more effective than traditional methods for long-term retention and practical application [2].

3.3 Pronunciation and Listening Skills

Pronunciation and listening skills improved by an average of 25%, with notable progress in stress patterns, intonation, and connected speech. Students utilized pronunciation apps and audio-based activities, including recordings of native speakers and self-recording exercises, to enhance accuracy. Listening comprehension exercises, such as video-based quizzes and dictation tasks, helped students recognize various accents and speech rhythms. Observations indicated that repeated exposure to authentic language materials and immediate feedback from technology contributed significantly to learners' confidence in speaking and listening tasks. These findings are in line with previous studies emphasizing the role of multimedia in improving phonological awareness and auditory discrimination skills [4].

3.4 Motivation and Engagement

Student motivation and engagement showed a remarkable increase, with 90% of participants reporting higher levels of enthusiasm and interest in learning English. Multimedia content, gamified tasks, and immediate feedback mechanisms were key factors in this improvement. For example, students reported enjoying competitive quizzes on Kahoot, interactive vocabulary games, and collaborative writing tasks on Google Docs. Teachers observed greater participation in

classroom discussions and a reduction in speaking anxiety among students. Increased motivation not only enhanced engagement during lessons but also encouraged autonomous learning outside the classroom, as students continued using apps and platforms to practice English independently.

3.5 Challenges Identified

Despite the overall positive outcomes, several challenges emerged during the study:

- Limited device access or internet connectivity: Some students faced difficulties participating fully in digital activities due to a lack of personal devices or unstable internet connections.
 - Technical difficulties: Occasional software glitches, compatibility issues, and unfamiliarity with certain applications interrupted learning activities.
 - Insufficient teacher training: Some educators lacked the necessary skills and experience to integrate technology effectively, which sometimes limited the potential benefits of digital tools.
- These challenges highlight the importance of adequate infrastructure, technical support, and professional development programs for teachers to ensure successful technology integration in ELT.

Table 1: Pre- and Post-Test Comparison

Skill	Before(%)	After(%)	Improvement (%)
Vocabulary	60	92	32
Grammar Accuracy	65	93	28
Pronunciation Accuracy	70	95	25
Motivation (self-report)	Medium	High	90

Overall, the results demonstrate that the use of technology in English language teaching leads to measurable improvements in linguistic skills, learner engagement, and motivation. While challenges remain, the positive impact of interactive applications, online platforms, and multimedia resources suggests that technology is a highly valuable tool in modern ELT classrooms.

4. Discussion

The results of this study clearly demonstrate that the integration of technology in English Language Teaching (ELT) significantly enhances the learning process by promoting interactive and student-centered learning. Technology allows teachers to create lessons that go beyond traditional lecture-based methods, providing opportunities for learners to engage actively with the content. Mobile applications, such as Duolingo, Quizlet, and Memrise, not only accelerate vocabulary acquisition but also provide spaced repetition and gamified learning experiences, which make the retention of new words more effective and long-lasting. These tools also support contextual grammar practice, allowing students to apply grammatical rules in meaningful and practical scenarios rather than relying solely on rote memorization, which has traditionally been less engaging and less effective.

In addition, technology improves listening and pronunciation skills through audio-visual materials and speech recognition applications. Students can listen to native speakers, record their own voices, and receive immediate feedback on pronunciation accuracy, stress patterns, intonation, and connected speech. This multimodal engagement caters to different learning styles, particularly auditory and visual learners, and encourages a more holistic approach to language acquisition.

Gamification and multimedia-rich learning environments play a crucial role in enhancing cognitive processing and memory retention. Features such as interactive quizzes, point systems, badges, and leaderboards create motivation and encourage voluntary practice outside the classroom.

Previous studies have shown that incorporating game elements in language learning increases student motivation, reduces language anxiety, and fosters sustained engagement in challenging tasks [3; 4]. Collaborative digital platforms, such as Google Docs, Padlet, and Flipgrid, further encourage interaction among peers, promote teamwork, and provide authentic opportunities for communication in the target language. Through collaborative tasks, students not only practice linguistic skills but also develop critical thinking, problem-solving, and digital literacy skills, which are essential in the 21st century.

However, despite these clear advantages, the implementation of technology in ELT presents several challenges that require careful consideration. Unequal access to digital devices and reliable internet connections can create disparities among students, potentially limiting the benefits of technology-enhanced instruction. Additionally, insufficient teacher training in digital pedagogy and unfamiliarity with technological tools can hinder the effective use of these resources, leading to suboptimal learning outcomes. Therefore, strategic planning, professional development programs for teachers, and institutional support are essential to ensure that technological integration is both effective and inclusive.

Future research in this area could investigate the long-term effects of technology-based ELT on language proficiency and retention, including how consistent use of digital tools influences learners' communicative competence over extended periods. Comparative studies between traditional, blended, and fully digital classrooms could provide deeper insights into the relative effectiveness of different teaching approaches. Moreover, the rapid development of artificial intelligence (AI) in educational technology opens new possibilities for personalized learning, adaptive feedback, and intelligent language tutoring systems, which could further enhance student learning and engagement.

Overall, this discussion emphasizes that while technology is a powerful tool in ELT, its success depends not only on the availability of digital resources but also on thoughtful integration, continuous teacher support, and the alignment of technological use with pedagogical objectives. When carefully implemented, technology can transform English classrooms into highly interactive, motivating, and effective learning environments, ultimately improving both language skills and learner confidence.

5. Conclusion

The findings of this study indicate that technology is a highly effective supplement to traditional English teaching methods. When thoughtfully and strategically implemented, technological tools can significantly enhance the overall language learning experience for students. Specifically, technology contributes to the improvement of essential language skills, including vocabulary acquisition, grammar comprehension, pronunciation accuracy, and listening proficiency. Mobile applications, online platforms, and multimedia resources offer interactive and engaging methods that make the learning process more enjoyable, while also providing students with opportunities to practice independently and at their own pace.

In addition to skill development, technology facilitates collaborative and autonomous learning. Tools such as Google Docs, Padlet, and digital storytelling platforms allow learners to work together on projects, exchange ideas, and communicate in English in meaningful contexts. At the same time, mobile apps and online exercises promote self-directed study, encouraging students to take responsibility for their learning and track their own progress. This combination of collaborative and individual learning enhances motivation and fosters a sense of ownership over the learning process.

Moreover, the use of technology enhances learner engagement and builds confidence. Gamified applications, multimedia lessons, and interactive exercises reduce anxiety, create a supportive learning environment, and encourage students to participate more actively in classroom activities. Increased engagement not only improves language retention but also contributes to the development of critical thinking, creativity, and digital literacy skills, which are essential in modern education.

However, the successful integration of technology into ELT requires careful planning and adequate support. Infrastructure, such as access to devices and reliable internet connectivity, must be ensured for all students to prevent inequalities. Additionally, teachers need appropriate training in digital pedagogy and familiarity with technological tools to implement them effectively. Without these supports, the potential benefits of technology may not be fully realized, and some learners may be disadvantaged.

In conclusion, technology should be viewed as a complementary component of English language teaching, rather than a replacement for traditional methods. By combining conventional instruction with digital tools, educators can create dynamic, interactive, and student-centered learning environments that optimize language acquisition, enhance engagement, and improve learner confidence. Future educational strategies should focus on the thoughtful integration of technology, continuous professional development for teachers, and the adoption of innovative tools, such as AI-driven language learning applications, to further improve outcomes in ELT.

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ЖОҒАРЫ БІЛІМДЕ ХИМИЯНЫ ОҚЫТУДАҒЫ ЭКОЛОГИЯЛЫҚ-БАҒДАРЛЫ ИННОВАЦИЯЛАР ЖӘНЕ ОЛАРДЫҢ КӘСІБИ ДАЯРЛЫҚҚА ӘСЕРІ

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Аңдатпа. Бұл мақалада жоғары білім беру жүйесінде химияны оқытудағы экологиялық-бағдарлы инновациялар мен олардың болашақ химия мамандарының кәсіби даярлығына ықпалы қарастырылады. Тұрақты даму талаптары, жасыл химия тұжырымдамасы, цифрлық технологияларға негізделген экологиялық оқу ортасын қалыптастырудың маңызы талданады. Мақалада химиялық білім беруді экологияландыру арқылы студенттердің кәсіби құзыреттілігін арттырудың тиімді жолдары көрсетілген.

Кілт сөздер: инновациялық технологиялар, химия, экология, білім беру, кәсіби даярлық.

Кіріспе. Қазіргі жаһандық дамудың жаңа кезеңінде экологиялық тұрақтылық мәселесі ғылым мен өндірістің ғана емес, білім беру жүйесінің де басты стратегиялық бағытына айналды. Қоршаған ортаның ластануы, табиғи ресурстардың сарқылуы, техногендік тәуекелдердің артуы сияқты факторлар болашақ мамандардың кәсіби даярлығында экологиялық жауапкершілік пен тұрақты даму принциптерін басымдыққа қоюды талап етеді. Осы тұрғыдан алғанда, химияны оқыту үдерісін экологияландыру және оған инновациялық технологияларды енгізу жоғары білім беру саласының өзекті міндеттерінің бірі болып табылады.

Химия ғылымы табиғи және техногендік процестердің негізін ашатын әмбебап сала болғандықтан, студенттерді кәсіби даярлаудың мазмұны қазіргі индустрияның экологиялық талаптарымен үйлесуі қажет. Экологиялық-бағдарлы инновациялар — жасыл химия принциптері, цифрлық және виртуалды зертханалар, энергия үнемдеуге бағытталған технологиялар, проблемалық және жобалық оқыту әдістері болашақ мамандарға теориялық біліммен қатар экологиялық қауіпсіз әрекет ету мәдениетін меңгертеді. Бұл инновациялар білім алушылардың зерттеушілік қабілетін дамытып қана қоймай, экологиялық ойлау мен өндірістік процестерді оңтайландыруға қажетті кәсіби құзыреттіліктерді қалыптастырады.

Соңғы жылдары халықаралық ғылыми қауымдастық университеттерде жасыл химияны оқыту, тұрақты индустрияның талаптарына бейімделген білім бағдарламаларын әзірлеу, экологиялық сананы арттыру бағытында ауқымды зерттеулер жүргізуде. Бұл тренд Қазақстанның жоғары білім беру жүйесінде де айқын байқалады. Елдің индустриялық-инновациялық даму стратегиясы мен «жасыл экономика» тұжырымдамасы химия мамандарын экологиялық мәдениеті жоғары, инновациялық ойлайтын, технологиялық

үдерістердің қоршаған ортаға әсерін бағалай алатын кәсіби тұлға ретінде қалыптастыруды талап етеді.

Осыған байланысты жоғары білімде химияны оқытудағы экологиялық-бағдарлы инновациялардың мазмұнын, оларды оқу үдерісіне енгізудің тиімді тәсілдерін және студенттердің кәсіби даярлығына тигізетін ықпалын жан-жақты талдау ғылыми әрі практикалық тұрғыдан өзекті болып отыр.

Негізгі бөлім. Қазіргі жоғары білім беру жүйесінде химияны оқытудың тиімділігі оқу процесіне енгізілетін инновациялық педагогикалық технологиялардың сапасына тікелей байланысты. Скрипко Л.Е. инновациялық әдістерді оқу үдерісіне енгізу білім беруді жаңғыртудың басты тетігі екенін атап өтеді [1]. Оның пікірінше, инновациялар болашақ мамандардың ойлау мәдениетін кеңейтіп, кәсіби мәселелерді өз бетінше шешу қабілетін қалыптастырады. Бұл тұжырым экологиялық-бағдарлы білім берудің мазмұнымен өзара қабысады, себебі жасыл химияға негізделген сабақтар студенттің экологиялық жауапкершілігін арттырып, табиғи ресурстарды тиімді басқаруға бағытталған кәсіби дағдыларды қалыптастырады.

Химия ғылымы — экологиялық проблемаларды түсіндірудің негізгі пәндерінің бірі. Сондықтан экологияландырылған инновациялық технологияларды қолдану дәстүрлі оқытудың шеңберінен шығып, химиялық білімнің мазмұнын тұрақты даму талаптарына қарай бейімдеуге мүмкіндік береді. Бұл болашақ мамандардың өндірістегі экологиялық тәуекелдерді бағалау және оларды болдырмау қабілеттерін дамытуға жағдай жасайды.

Жоғары білім беру жүйесінде химияны оқыту үдерісін экологияландыру қазіргі қоғамның тұрақты даму талаптарына толық сәйкес келеді. Экологиялық-бағдарлы инновациялар дегеніміз — оқу мазмұнын, әдістерін және технологияларын қоршаған ортаны қорғау, ресурсты тиімді пайдалану, жасыл технологияларды қолдау идеясымен ұштастыра енгізу. Мұндай инновациялар студенттің теориялық білімімен қатар, практикалық дағдыларын дамытып, кәсіби әрекеттегі экологиялық жауапкершілік деңгейін арттырады. Л.Е. Скрипконың инновациялық оқытуға арналған зерттеуінде, білім беру үдерісіне жаңашыл әдістерді енгізу көптеген артықшылыққа ие бола отырып, педагогтар тарапынан мақсатты дайындықты талап ететіні атап өтіледі. Ол инновациялық технологиялардың оқыту тиімділігін арттыруға қабілетті екенін, алайда іске асыру барысында белгілі бір ұйымдастырушылық және әдістемелік қиындықтар туындайтынын көрсетеді. Бұл идея химия пәнінде экологиялық мазмұнды енгізген кезде де өзектілігін жоғалтпайды: оқытушы инновациялық әдісті меңгерген жағдайда ғана қажетті сапалық өзгеріс орын алады.

Экологиялық бағыттағы инновациялар химия пәнінің мазмұнын қазіргі ғылыми жетістіктермен байланыстырып, студенттің кәсіби бағдарын нақтылауға мүмкіндік береді. Мысалы, жасыл химия, экотехнология, өндірістік қауіпсіздік, қалдықсыз өндіріс принциптері оқу бағдарламасына енгізілген жағдайда студенттің кәсіби даярлығы кеңейіп, еңбек нарығына бейімделу деңгейі артады.

Жасыл химия қағидаларын оқу мазмұнына енгізу. Жасыл химия (Green Chemistry) 12 қағидаға негізделген экологиялық қауіпсіз химиялық синтез философиясы. Оқу үдерісінде жасыл химияны қолдану студенттерді қауіпті реагенттерді алмастыру, катализаторларды пайдалану, энергияны үнемдеу, қалдықсыз реакциялар жасау сияқты заманауи тәсілдермен таныстырады. Мысалы, органикалық химия курсында: нитрлеу, хлорлау сияқты қауіпті реакциялар орнына каталитикалық гидрогендеу; улы еріткіштер орнына суда өтетін реакциялар; көп сатылы синтездің орнына бір ыдыста өтетін (one-pot) реакциялар қарастырылады. Бұл студенттің кәсіби ойлауын экологиялық тұрғыдан қайта құруға мүмкіндік береді.

Экологияландырылған зертханалық жұмыстарда: қалдық мөлшері азайтылған микроәдістер; улы реагенттердің орнына қауіпсіз баламалар; химиялық қалдықтарды жинау,

сұрыптау, бейтараптандыру тәсілдері; экологиялық қауіпсіздік нормаларына негізделген нұсқаулықтар қолданылады [2]. Мысалы: қышқыл-негіз титрлеу жұмыстарында HCl орнына әлсіз қышқылдарды қолдану; органикалық синтезде ацетон орнына этанол немесе су қолдану; хром қоспасы орнына темір(III) тұздары арқылы тотығу реакцияларын жүргізу. Бұл студенттің зертханалық мәдениетін қалыптастырып қана қоймай, кәсіби ортадағы экологиялық қауіпсіздікке дайындықты арттырады.

Химиялық үдерістердің экологиялық салдарын бағалау қабілеті. Студент химиялық реакция теңдеулерін жазып қана қоймай: көмірсутектердің жану өнімдерін (CO , CO_2 , NO_x) есептейді; азот тыңайтқыштарының артық мөлшерде енгізілуінің экологиялық салдарын талдайды; металдардың коррозиясы нәтижесінде қоршаған ортаға бөлінетін иондарды зерттейді [3]. Тәжірибені қауіпсіз ұйымдастыру және қалдықтарды басқару дағдылары. Химия саласындағы маман экологиялық қауіпсіздік нормаларын міндетті түрде меңгеруі қажет. Оқыту барысында студент: қышқыл, сілті, органикалық еріткіш қалдықтарын бөлек жинауды; ұлы қалдықтарды бейтараптандыруды (мысалы, $\text{Cr(VI)} \rightarrow \text{Cr(III)}$); сынап термометрлері мен аккумуляторларды қауіпсіз утилизациялауды; реактивтерді сақтау мен тасымалдау ережелерін практикада меңгереді.

Қорытынды. Жоғары білім беруде химияны экологиялық-бағдарлы инновациялар негізінде оқыту – қазіргі заман талаптарына сай, сапалы кәсіби даярлықтың негізгі факторы болып табылады. Бұл тәсіл арқылы тиімді әдістерді дұрыс таңдау студенттің кәсіби құзыреттілігін кешенді түрде күшейтіп, оны еңбек нарығында сұранысқа ие маман деңгейіне жеткізеді. Бұл инновациялық бағыттың құндылығы студенттің келесі негізгі құзыреттіліктерін қалыптастыруында:

Кешенді және жүйелі білім: студенттер химиялық білімді тек теориялық тұрғыдан меңгеріп қана қоймайды, сонымен бірге осы білімнің қоршаған ортаға тигізетін әсерін терең түсінеді. Олар химиялық процестерді экологиялық қауіпсіздік тұрғысынан бағалауды және оңтайландыруды үйренеді. Бұл олардың кәсіби ойлауындамытады.

Экологиялық жауапкершілік және зертханалық мәдениет: оқыту барысында зертханалық мәдениеттің жоғары деңгейіне, қауіпсіз реагенттерді қолдануға және қалдықтарды дұрыс басқаруға баса назар аударылады. Осылайша, студенттерде экологиялық жауапкершілік қалыптасып, олар химия саласындағы жұмыстың этикалық және әлеуметтік аспектілерін ескеретін саналы маман болып шығады. Экологиялық-бағдарлы даярлықтан өткен химия мамандары инновациялық өндірістерде, қоршаған ортаны қорғау ұйымдарында және сапа бақылау зертханаларында ерекше қажеттілікке ие болады. Себебі, олар қазіргі заман талап ететін технологиялық шешімдерді экологиялық тұрғыдан негіздей алады.

Қорытындылай келе, жоғары білім беруде химияны экологиялық-бағдарлы инновациялар негізінде оқыту – маман даярлау жүйесін жаңғыртудың негізгі тетігі. Бұл тәсіл түлектердің кәсіби құзыреттілігін, зертханалық мәдениетін, кәсіби ойлауын және тұрақты даму бағытындағы құндылықтарын қалыптастыра отырып, олардың еңбек нарығында бәсекеге қабілетті және қоғам алдындағы жауапкершілігі жоғары маман ретінде қалыптасуына айтарлықтай ықпал етеді.

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ТЕОРЕТИЧЕСКИЕ ОСНОВЫ МУЗЫКАЛЬНО-ЭСТЕТИЧЕСКОГО ВОСПИТАНИЯ УЧАЩИХСЯ НАЧАЛЬНОЙ ШКОЛЫ В ПРОЦЕССЕ ХОРОВОГО ПЕНИЯ

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Во все времена существования человечества музыке и музыкальному образованию отводилось особое место. По мнению многих видных ученых, именно музыкальное искусство являлось действенным средством «воспитания души и сердца». Музыка помогает лучше, глубже, шире познавать жизнь, вызывает благородные, возвышенные мысли, чувства.

«Музыка – одно из сильнейших орудий воспитания каждого человека...» - пишет Д. Шостакович.

Что же нужно сделать для того, чтобы музыка действительно сыграла свою роль в воспитании подрастающего поколения?

Во-первых, научить детей понимать и любить музыку, во-вторых, воспитать у них художественный вкус, научить ценить подлинно художественные произведения и, в-третьих, развить музыкальные способности детей – их слух и память, так «для немзыкального уха прекраснейшая музыка не имеет никакого смысла» (К. Маркс).

Данные задачи расположены в такой последовательности, потому что, прежде всего необходимо научить детей любить и понимать музыку, слушать ее. И тогда музыка откликнется в сердце ребенка и вызовет в нем эстетические переживания.

Говоря о художественном вкусе и его воспитании, стоит отметить, что сейчас на просторах интернета много пошлой и вульгарной музыки, которую дети, в том числе, любят и «обожают» слушать. В современной социокультурной ситуации музыка все больше выдвигается на первый план в структуре художественных предпочтений молодежи. Она опережает другие виды искусства по количеству потребления в силу своих чувственных особенностей воздействия. Но за подобной картиной воздействия скрыты сложные противоречия восприятия ценностных ориентаций в музыкальном искусстве. Например, это односторонний уклон большинства людей к эстрадно-развлекательной музыке, к той небольшой части огромного мира музыкального искусства, не требующей больших интеллектуальных и нравственных усилий для постижения. Современные средства массовой информации создали возможность «растворения» музыки в быту, досуге, работе. Становится все труднее воспринимать музыку как художественное целое. Привычной становится возможность слушать музыку как фон, полноценно не воспринимая ее. Подобный уровень культуры восприятия музыки формирует поверхностно-потребительский тип музыкальной культуры в целом, когда не происходит полного восприятия эмоциональных, интеллектуальных, нравственно-гуманистических сторон музыкального произведения. Место отсутствующей культуры отношений к музыкальным ценностям занимают потребительские запросы, диктуемые престижностью, модой. За внешним пристрастием к музыке стоит поверхностный контакт с музыкальными произведениями в

исключительно развлекательных целях, который является ущербным для личности. Он противоречит потенциально-гуманистическим возможностям музыкального искусства.

Задача педагога-музыканта – научить школьников любить, ценить и понимать не музыку вообще, а музыку подлинно художественную, музыку больших идей и чувств.

Рассмотрению проблем музыкально-эстетического воспитания, влияния музыкального искусства на формирование духовного мира личности посвящено довольно значительное количество работ в педагогике, эстетике, музыковедении.

Основополагающие подходы к проблемам эстетического воспитания, в основе которых заложена целая система общекультурного влияния на личность, были обозначены в Древней Греции и нашли свое отражение в учениях Сократа и Аристотеля [75, 121]. Гуманисты эпохи возрождения Ф. Рабле, Т. Кампанелла, Т. Мор [75, 191], пропагандируя идею гармоничного развития личности, подчеркивали необходимость эстетического воспитания через занятия различными видами искусства.

Аль-Фараби утверждал, что музыка, как любое снадобье, может быть и ядом, и средством исцеления. Согласно его музыкальному трактату, «Большая книга музыки», в вопросах целительной силы все зависит от характера музыки. Изучив характер и структуру звуков, он обращал внимание не только на каноны «музыкальной науки», но и на комплекс эстетических и теоретических принципов музыки. Более того, свой трактат великий мыслитель писал в теологическом обществе, которое раздирали споры: слушание музыки – запретно (харам) или это дар свыше? Согласно социально-этическим взглядам Аль-Фараби, музыкальное искусство – есть проводник добродетели, гарант и одновременно признак счастья и добродетельности.

Тема эстетического воздействия музыки на человека достаточно полно разработана в трудах русских и зарубежных педагогов, психологов. Среди них Д. Н. Джола, Д. Б. Кабалецкий, Д. С. Лихачев, А. С. Макаренко, Б. М. Неменский, В. А. Сухомлинский, В. Н. Шацкая и другие.

С. Лихачев писал: "Массовой культуре, с завидной энергией вторгающейся в нашу жизнь, следует противопоставить высокую культуру, имеющую народную, эмоциональную основу - в том одна из задач эстетического и нравственного воспитания".

В книге Шацкой В. Н. «Музыкально-эстетическое воспитание детей и юношества» изложены материалы многолетних исследований автора по основным вопросам музыкально-эстетического воспитания. Автор рассматривает сложную и многогранную проблему массового музыкального воспитания детей и юношества и, как составную часть общего формирования личности, и прочим отдельным вопросам проблемы — развитие музыкального вкуса, интересов, способностей и т. д.

В учебном пособии В. П. Андрющенко «Психолого-педагогические особенности формирования готовности студентов к музыкально-эстетической деятельности» обобщается психолого-педагогический опыт и данные исследования ряда актуальных проблем подготовки учителей музыки для музыкально-эстетического воспитания подрастающего поколения на современном этапе социального развития.

И. С. Байдалинова в статье «Формирование культуры поведения младших школьников в условиях культурно-досуговой деятельности вокально-хоровой студии» (журнал «Наука и школа», 2016) раскрывает теоретические аспекты формирования культуры поведения младших школьников средствами вокально-хорового искусства. Рассматриваются особенности культурно-досуговой деятельности вокально-хоровой студии, как оптимальной среды формирования культуры поведения младших школьников средствами вокально-хорового искусства.

И. Г. Лаптев в статье «К вопросу об активизации музыкально-эстетического просвещения младших школьников» рассматривает животрепещущую проблему

музыкально-эстетического просвещения младших школьников. Приведены убедительные доводы исследователей-педагогов о необходимости активизации методов музыкально-эстетического просвещения. Это, прежде всего, лекции-концерты в филармонии, в музыкальных учебных заведениях, в школе средствами инструментального и вокально-хорового искусства, а также аналитической интерпретации музыкальных произведений. Важной задачей учителя является формирование средствами музыкального искусства чувства социальной ответственности, чувства патриотизма, любви к Родине, к малой Родине.

Казахские ученые, философы и педагоги, такие как Абай Кунанбаев, Ыбырай Алтынсарин, Шокан Уалиханов, Ахмет Жубанов широко раскрывали проблему эстетического воспитания.

Великий мыслитель Абай хорошо понимал значение музыки в жизни общества, рассматривая искусство как средство, способное обновить человека. Для него поэт, музыкант – это борец за правду. Требования Абая к искусству – это значительность мысли, чистота и весомость слова, выразительность мелодии.

Этическая проблематика занимает значительное место в произведениях И. Алтынсарина, в них красной нитью проходит мысль о судьбе человека, его идеалах, о путях воспитания высоконравственной личности. Современники отмечали, что в произведениях Алтынсарина они видят «сильного проводника чистых истин нравственности общечеловеческой и через это заслуга его превышает всякую похвалу». Этика Алтынсарина – это этика народа, и носит она практический характер. Наследие Алтынсарина полезно для современности с определенной корректировкой на время. Основу нравственности по Ибраю Алтынсарину составляет образование и воспитание: «Только постоянная забота и нравственное воспитание формирует в ребенке самые лучшие нравственные качества», «хорошо воспитанный ребенок впоследствии остается добропорядочным человеком».

Нравственно-этические позиции Чокана Валиханова являются теоретико-методологическим источником развития основ теории нравственного воспитания школьников Казахстана. В его труды были заложены основные положения о закономерностях, принципах, целях, задачах, содержании, формах, методах и средствах формирования морального облика личности. Основными факторами воспитания личности Валиханов считал среду и воспитание, а цель морального облика человека видел в воспитании нравственно ориентированной личности, задачи – в воспитании нравственных качеств личности.

Таким образом, провозглашенные в прошлом Абаем Кунанбаевым, Ибраем Алтынсариним, Чоканом Валихановым моральные нормы, их высшие этические идеалы не только не утратили своего значения в наше время, а приобрели новую силу звучания и требуют пристального изучения и овладения, прежде всего учащимися.

Также известны учебные пособия, монографии и статьи современных казахстанских музыкантов, педагогов, среди которых П. Момынұлы, Ж. Б. Шокаманова, А. С. Шадиярова, Р. Н. Наурызбаева, Б. Ж. Кокумбаева, А. А. Сметова, А. Б. Мукашева, Г. Г. Ахметова, Р.К. Дюсембинова, Т.А. Букирова, С.Узакбаева. Группа исследователей по руководством С.А. Узакбаевой изучила педагогические возможности устного казахского музыкального творчества. Данное исследование проводилось в системе непрерывного музыкально-эстетического образования в русле программы «Елім-ай», создание которой принадлежит профессору М.Х. Балтабаеву.

В учебном пособии Сметовой А. А. «История развития музыкального образования и воспитания в Казахстане» рассматриваются теоретико-методологические аспекты музыкального образования, история развития музыкального образования и воспитания в Казахстане, раскрыто содержание и формы работы музыкально-эстетического воспитания в системе культурно-просветительских учреждений.

Осознанное восприятие ценностей музыкальной культуры начинается в младшем школьном возрасте. У каждого школьника есть способности и таланты. Дети от природы любознательны и полны желаний учиться. Проявления творчества характерны для ребенка с самого раннего возраста, так как творчество – это норма детского развития. В музыкальном творчестве ведущую роль играет синтез эмоциональной отзывчивости и мышления (абстрактного и конкретного), логики и интуиции, творческого воображения и активности, способности принимать быстрые решения и мыслить аналитически. Творческое начало рождает в ребенке живую фантазию и воображение.

Творчество по природе своей основано на желании сделать то, что до тебя еще никем не было сделано. Музыкально-эстетическое воспитание учащихся. На уроках музыки осуществляется посредством вовлечения их в процесс собственного художественного созидания, социально-значимого по сущности и направленного на познание и освоение окружающего мира.

Цели таких уроков:

1. Всестороннее развитие личностно-творческого потенциала и эстетической культуры школьника.
2. Оптимизация мышления и познавательной деятельности.
3. Раскрытие преобразующей силы музыки и ее влияния на внутренний мир человека, его отношение к окружающей действительности.
4. Овладение образным языком музыкального искусства посредством усвоения знаний.

Развитию творческих способностей свойственны определенные этапы:

1. Накопление впечатлений.
2. Сенсорно-моторные и речевые направления.
3. Импровизация двигательная, речевая, музыкальная.

Включение в структуру уроков игровых ситуаций позволяет вовлечь учащихся в творческую деятельность, что является необходимым условием формирования творческих способностей у младших школьников. В творческом коллективе дети учатся терпению, выдержке, взаимопониманию. Задача музыкального воспитания – комплексное развитие нравственных и эстетических чувств ребенка, его воображения, творческих и специальных музыкальных способностей.

Ребенок младшего школьного возраста получает знания, приобретая при этом навыки самостоятельного мышления, творческого восприятия окружающего мира. Все виды музыкальной деятельности на уроках хора должны способствовать творческому развитию учащихся, то есть вырабатывать в них стремление сделать что-то новое и лучшее. Ребенок творит ради радости. И эта радость собственного преодоления и успеха в труде способствует приобретению веры в себя, уверенности в своих силах, формированию целостной творческой личности. Русский советский музыковед Б.В. Асафьев писал: «Каждый, кто хоть немного ощутил в какой-либо сфере искусства радость творчества, будет в состоянии воспринимать и ценить все хорошее, что делается в этой сфере, и с большей интенсивностью, чем тот, кто только пассивно воспринимает».

Одним из важнейших условий музыкально-эстетического воспитания является организованный процесс восприятия учебного материала с учётом возрастных особенностей детей.

«Возрастные особенности - специфические свойства личности, индивида, его психики, закономерно изменяющиеся в процессе смены возрастных стадий развития. Возрастные особенности образуют определенный комплекс многообразных свойств, включая познавательные, эмоциональные, мотивационные и другие характеристики

индивида. Возрастные изменения, в отличие от широко варьирующихся индивидуальных особенностей, отражают такие преобразования, которые происходят в психике большинства представителей данной культуры или субкультуры при сравнительно одинаковых социально-экономических условиях. Возрастные особенности не проявляются в «чистом виде» и не имеют абсолютного и неизменного характера, они испытывают влияние со стороны культурно-исторических, этнических и социально-экономических факторов. Особое значение имеет учет возрастных особенностей в процессе обучения и воспитания.

Общую схему периодизации становления человека разработали Л.С. Выготский, А.Н. Леонтьев и Д.Б. Эльконин.

В основу выбранной периодизации исследователи взяли представление о том, что каждому возрасту, как своеобразному и качественно-специфическому периоду жизни человека, соответствует определенный тип ведущей деятельности. Изменение содержания деятельности характеризует смену возрастных периодов:

- непосредственное эмоциональное общение с взрослыми присуще человеку с первых недель его жизни и до года;

- предметно-манипуляторная деятельность свойственна ребенку от 1 года до 3 лет жизни. Характерным для этого возраста является возникновение у ребенка собственного детского “Я”;

- детям от 3 до 6 лет наиболее характерна игровая деятельность, в процессе которого у него развивается воображение, формируются обобщенные переживания и осмысленная ориентация в них;

- у детей возрастной группы от 6 до 10 лет формируется учебная деятельность. На ее основе у младших школьников возникает теоретическое сознание и мышление, развиваются соответствующие им способности – рефлексия, анализ, мысленное планирование, а также потребности и мотивы учения;

- детям от 10 до 15 лет характерны учебная, трудовая, общественно-организационная, спортивная и художественная виды деятельности. У подростков возникает стремление участвовать в любой общественно необходимой работе, умение строить общение в различных коллективах с учетом принятых в нем норм взаимоотношений, рефлексия на собственное поведение, умение оценивать возможности своего “Я”;

- старшекласники и учащиеся организаций ТИПО в возрасте от 15 до 17-18 лет выполняют учебно-профессиональную деятельность. У них развиваются профессиональные интересы, потребности в труде, формируются элементы исследовательских умений, способность строить свои жизненные планы, нравственно-эстетические и идейно-гражданские качества личности и устойчивое мировоззрение.

Возрастные психологические особенности детей начальных классов зависят от предшествующего психического развития детей, от их готовности к отклику, как на музыку, так и на воспитание взрослых. Этот возрастной период занимает ключевое место в психологии, потому что обучение в школе является новым этапом психологического развития человека. Учебная деятельность начинает приобретать большое значение для младшего школьника, появляется познавательная активность, стремление к саморазвитию. Успехи в учебе способствуют формированию его адекватной самооценки, а неудачи в учебе зачастую приводят к формированию комплексов неполноценности или развитию синдрома хронической неуспеваемости.

К важнейшим личностным характеристикам учащихся начальной школы относятся: доверчивое подчинение авторитету, повышенная восприимчивость, внимательность. В поведении проявляются послушание, конформизм, подражательность. В младшем школьном возрасте складываются наиболее благоприятные условия для формирования нравственных качеств и положительных черт личности ребенка. Учитель является для него

авторитетом, поэтому учитель должен создать благоприятные условия для формирования высоконравственной личности.

У учащихся начальной школы преобладает наглядно-образный тип мышления, они обращают внимание на все яркое, поэтому при обучении младших школьников должны учитываться эти психические особенности. Для более продуктивного обучения необходимо учитывать специфику памяти детей. Учащиеся начальной школы легко и прочно запоминают небольшой по объему языковой материал и хорошо его воспроизводят. Запоминание носит механический характер, который основан на многократном повторении и силе впечатления процесса восприятия. Педагог должен знать особенности учащихся начальной школы, чтобы лучше строить процесс урока.

Возрастные психологические особенности – это только ориентир для более объективного суждения педагога о своих учениках.

Приведем наиболее типичные, чаще всего встречающиеся показатели возрастных психологических особенностей детей младшего школьного возраста:

- моторная активность;
- сенсорно-перцептивная активность – способность и потребность в сенсорных новых впечатлениях, их воспроизведении, сохранении;
- интеллектуально-волевая активность – интеллектуальная инициативность, любознательность, интерес к выявлению связей, причинно-следственных отношений, объективация и воспроизведение “трудных” ситуаций, выделения себя и поля действия и т.д.;
- мотивация и эмоционально-выразительная активность – социальный диапазон жизненных мотивов, способность их к эмоционально-выразительному выявлению, обозначению, символизации, замещению;
- способность к включению всех этих форм психической активности в реальную социальную деятельность, поведение, общение во имя их эффективного построения, регулирования и социальной оценки.

Первые четыре показателя, по мнению учёных, естественно проявляются в деятельности детей этого возраста. В психологическом смысле последний показатель определяет позицию ребенка уже как школьника, деятельность которого характеризуется всеми основными чертами общественно-полезной деятельности. Поражение этой способности, отрицательная оценка ведет к нарушению преемственности с предшествующим психическим развитием. А воспитание способности к целевой регуляции деятельности через поощрение, положительную оценку успехов детей сохраняет богатство предшествующих достижений психического развития младших школьников.

Действия в соответствии с требуемым результатом формирует у детей такие качества, как устойчивость поведения, способность к мобилизации, к действию с учетом фактора времени, к регуляции своих состояний в соответствии с достигаемым результатом.

Объективно существующие особенности младших школьников излагает в своём исследовании Г.С. Тарасов:

- разрозненный, неорганизованный музыкальный опыт;
- недостаточная вокально-слуховая (иногда и двигательно-слуховая) координация;
- преобладание роли зрелищно-событийных впечатлений по отношению к слуху;
- потребность в смене эмоциональных состояний, своеобразная импульсивность, бесконтрольность эмоциональных состояний;
- склонность к непосредственному сопереживанию, эмоциональной идентификации в ситуации общения со взрослыми, с персонажами произведений музыки;

- регуляция деятельности, общения в опоре на чувственные ощущения, образы, но не на слово; стремление «увидеть» за словом конкретное представление, предпочтение тем словам, которые обобщают живые образы, представления детей;

- интеллектуально-волевая регуляция во имя субъективно привлекательных, «важных» причин;

- личностная доминанта: стремление к самовыражению в самых разнообразных формах - звуковых, зрительных, двигательных и т.д. [51, с. 36].

Если ребенок, начиная с колыбели, постоянно слушает хорошую музыку, то у него развиваются музыкальные способности и формируется определённый эстетический вкус. Замечено, что хороший музыкальный слух развивается у тех детей, которые занимаются пением в хоре или в любом другом музыкальном коллективе.

Как известно, пение – психофизический процесс. Он связан с работой жизненно важных систем, таких как дыхание, кровообращение, эндокринная система. Детский певческий голос отличается от голоса взрослого высоким головным звучанием, мягкостью, серебристостью тембра, небольшим диапазоном, ограниченностью силы звука. Важно, чтобы голосообразование было правильным, естественным, чтобы ребёнок при пении испытывал ощущение комфорта, пел легко и с удовольствием. Для этого необходимо знать физиологические особенности детей, и строить свою работу, опираясь на них. Условно детские голоса в хоре делят на 3 группы: младший хор учащихся: 7-9 лет, средний хор: 9-12 лет, старший хор: 12-15 лет. Соответственно выделяемым возрастным периодам меняется анатомическая структура голосового аппарата и голос ребенка, которые объясняют изменения акустических параметров: частоты основного тона, интенсивности голоса, диапазона и тембра. отличительными особенностями в строении и формировании отдельных органов голосового аппарата ребенка являются диспропорция в развитии отдельных органов голосового аппарата, неравномерность и скачкообразность в процессе развития, наличие периодов, когда развитие протекает почти незаметно, неоднородность окончания роста разных органов голосового аппарата. Например, легкие интенсивно развиваются в первые два месяца, а далее, вплоть до периода полового созревания их рост происходит постепенно. Выраженные изменения в бронхах и трахее отмечаются в течение первого года жизни ребенка. Изменения в гортани и носоглотке происходят в три стадии. Рост носоглотки и придаточных пазух обычно завершается к началу половой зрелости (к 8-9 годам), остальные же органы голосового аппарата прекращают рост к периоду окончания полового созревания (к 17 годам). Исключение составляет только гортань, продолжающая свой рост. У детей младшего школьного возраста (младший хор) специфический голосовой аппарат - голосовые связки у младших школьников ещё не сформированы, они короткие и тонкие. Согласно описанию, которое дается в исследованиях, касающихся изучения детского голоса, гортань восьмилетнего ребенка в 1,5 раза короче, чем у взрослого, и расположена несколько выше уровня, обычного для взрослого человека. Мышцы полости рта и язык малоподвижны, недостаточно эластичны, лёгкие малой ёмкости. Детский голосовой аппарат по размеру меньше, чем у взрослого, и менее совершенен. Естественное звучание детского голоса – «головное», этому возрасту свойственно фальцетное звукообразование, то есть колеблются лишь края голосовых связок. Дыхание у детей этого возраста слабое, поверхностное, так как диафрагма расположена выше, чем у взрослого. Довольно небольшой диапазон: «до» первой октавы - «до» второй октавы, «ре» - первой октавы - «ре» второй октавы. Нет существенного различия между звучанием голоса мальчиков и девочек. У детей младшего школьного возраста небольшая сила звука *p* (тихо) – *mf* (не очень громко). Певческое звукообразование происходит за счёт натяжения краёв связок, поэтому форсированное пение следует исключить, так как крикливость искажает тембр голоса, отрицательно влияет на выразительность исполнения.

Вследствие неравномерности роста различных частей голосового аппарата происходят и изменения голоса ребенка, поэтому детский голос требует осторожного отношения со стороны любого вокального педагога. Исследования последних лет показывают, что начинать вокальное воспитание детей лучше с дошкольного возраста. Возможности певческих голосов детей ограничены. Руководитель должен знать, что красота и прелесть детского звучания не в силе голоса, а в звонкости, полетности, эмоциональности. Форсирование, громкое звучание приносит вред голосу. Это объясняется природой детского голосового аппарата, так как при пении происходит неполное замыкание голосовой щели, вибрируют края голосовых связок, грудной резонатор развит слабо.

В силу возрастных особенностей объем, тембр и сила голоса у детей невелики, поэтому и певческие навыки их элементарны, несложны и примерно одинаковы у всех детей.

Детские голоса соответствуют примерно голосам женского хора. Отличие заключается в ширине диапазона (он несколько меньше). А также различен в характере звучания. Детские голоса более «светлые», «серебристые», нежели женские. Но существуют и индивидуальные особенности голосов детей. Например, в одной хоровой группе можно наблюдать резкие различия в диапазоне и индивидуальном характере звучания детских голосов. Среди чисто интонирующих есть дети, которые имеют в диапазоне звуки соль, ля, си малой октавы, и такие, которые имеют в диапазоне ре, ми, фа второй октавы. Но есть дети, имеющие неполный диапазон – 2-3 звука, у этих детей приближительная певческая интонация.

Правильное представление о примарных тонах, или зоне примарного звучания, переходных звуках и звуковом диапазоне детского голоса позволит хормейстеру определить удобный участок звуковой шкалы для пения, а также выбрать соответствующий репертуар, способствующий наилучшим образом на развитие детского голоса. Под примарными тонами (или примарной зоной) понимается наиболее лёгкое, правильное и естественное звучание нескольких звуков голоса, обычно находящееся в середине диапазона. При пении в примарной зоне все звенья голосового аппарата работают с естественной природной координацией. У большинства детей домутационного периода зона примарного звучания фа1 - ля1. Другие специалисты и педагоги считают, что примарная зона расположена довольно ниже и связана с функционированием аппарата в процессе речи. Выяснено, что эта зона в разные годы - до наступления мутационного возраста - меняется. Среднее значение высоты ре1 - ля1 поэтому распевание следует начинать с этих тонов.

В таком начальном этапе хорового воспитания закладываются профессиональные навыки пения: интонирование, вокальная техника, ансамблирование. В хоре все музыкальные способности, а именно мелодический, гармонический, тембровый, ритмический слух ребёнка развиваются гораздо быстрее, чем на других музыкальных занятиях. Особенно это касается выработки чистого интонирования.

Как показывает практика, уровень эстетического вкуса развивается не только на лучших образцах классической, народной, современной музыки, но и на сравнении высокохудожественной, высокоидейной музыки с низкопробной. В связи с этим, мы предполагаем, что на уроках музыки учитель, слушая вместе с ребятами популярные песни, трэки, анализируя их содержательную сторону сможет убедить их в низкопробности, каких-то недостатках, касающихся идейной стороны произведения, тем самым убедит и докажет детям свою правоту.

Таким образом, психологические особенности младших школьников, учёт развития музыкальных способностей, рост их познавательных сил будет способствовать формированию потребности в систематическом общении с музыкальным искусством, в развитии художественно-эстетического вкуса на уроках коллективного музицирования.

ХИМИЯНЫ ҚАШЫҚТЫҚТАН ОҚЫТУДА ВИРТУАЛДЫ ЗЕРТХАНАЛАРДЫҢ РӨЛІ МЕН ТИІМДІЛІГІ

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Аңдатпа. Бұл мақалада химия пәнін қашықтықтан оқыту барысында виртуалды зертханалардың алатын орны, оқу үдерісіне әсері, тиімділігі және педагогикалық артықшылықтары қарастырылады. Виртуалды лабораториялар студенттің эксперименттік дағдыларын қалыптастыруда қауіпсіз, қолжетімді және интерактивті оқу ортасын жасай отырып, дәстүрлі зертхана мүмкіндігін толықтыратыны айқындалады. Сонымен қатар, олардың білім сапасын арттырудағы рөлі мен болашақтағы қолдану перспективалары талданады.

Кілт сөздер: виртуалды зертхана, қашықтықтан оқыту, цифрлық технологиялар, web-платформа

Кіріспе. Қазіргі білім беру цифрлық технологиялардың, соның ішінде виртуалды зертханалардың дамуы арқасында айтарлықтай өзгерістерге ұшырауда, олар күрделі зертханалық тәжірибелерді зертханада физикалық қатысуды қажет етпей-ақ жүргізуге мүмкіндік береді. Виртуалды зертханалар студенттерге химиялық процестерді интерактивті түрде көруге және зерттеуге мүмкіндік беретін практикалық сабақтарға қол жеткізуге жағдай жасайды. Бұл әсіресе университет пен мектеп студенттері үшін пайдалы, себебі ол оларға сыни ойлау мен эксперименттік дағдыларды дамытуға және табиғи ғылымдарға деген қызығушылықты арттыруға мүмкіндік береді.

Білім берудегі цифрландыру бұл цифрлық білім беру ресурстары арқылы оқытуды дамыту. Цифрлық білім беру ресурстарын қолдану жаңа заманауи білім беру мүмкіндігін жоғарылату болып табылады [1]. Соңғы жылдары білім беруді цифрландыру ғылыми-техникалық салада оқытудың жаңа тәсілдерін пайдалануды қажет етеді. Қашықтықтан оқыту, әсіресе аналитикалық химия сияқты тәжірибеге негізделген пәндер үшін үлкен қиындықтар тудырады. Өйткені бұл пән белгілі бір құралдармен жұмыс істеуді, титрлеу, спектроскопия, хроматография сияқты әдістерді орындауды талап етеді. Мұндай жағдайда виртуалды зертханалар оқу процесіндегі олқылықтарды толтыруға мүмкіндік беретін заманауи шешім болып табылады.

Химия білім беру саласында виртуалды зертханаларды қолдану оқу мақсаттарына жетудің тиімді құралына айналуға, себебі ол оқу орындарындағы құрал-жабдықтар мен реагенттердің жетіспеушілігінен туындайтын шектеулерді еңсеруге мүмкіндік береді. Виртуалды зертханалар-бұл сандық ортада нақты химиялық экспериментті модельдейтін интерактивті бағдарламалар болып табылады. Олар студентке реакциялар жасауға, құралдарды реттеуге, өлшеулер жүргізуге, зертханалық жұмыстарды орындауға мүмкіндік береді. Бұл технология оқу сапасын төмендетпейді, керісінше оқу процесін жеңілдетеді, қауіпсіздікті арттырады және тәжірибені шексіз қайталауға мүмкіндік береді.

Негізгі бөлім. Зертхана-химияны үйренуде өте маңызды рөл атқарады, әсіресе оқушылар мен студенттер үшін. Ол оқушылар мен студенттердің ұғымдарды түсінуіне көмектесетін әртүрлі эксперименттік әрекеттерді жеңілдетеді. Дегенмен, көптеген шектеулер дәстүрлі химия зертханасында концептуалды бос орындарды жиі тудырады. Бұл шектеулерді жеңудің бір жолы- элементтерді виртуалды ортада визуализациялау.

Зертханалық жұмыс барысында алаңдатпайтын, виртуалды ортаны ұсынатын бұл виртуалды химия зертханалары мұғалімдер үшін жаңа тренд орнатып, оқытуды келесі деңгейге көтеруде. Олар оқушыларға химиялық тәжірибелерді ыңғайлы орындауға және әртүрлі химиялық заттар мен қосылыстар айналасында қауіпсіз жұмыс істеуге мүмкіндік береді.

Соңғы он жылдықта жоғары білімде химия практикалық оқуын қолдау мақсатында виртуалды зертханаларды (v-lab) әзірлеу мен енгізуге бағытталған зерттеулер айтарлықтай өсті [2]. Бұл үрдіс дәстүрлі зертханалық тәжірибелерде кездесетін жоғары шығындар, қауіпсіздік мәселелері, қолжетімділіктің шектеулі болуы және икемді оқу әдістеріне деген қажеттіліктің артуынан туындады. Сандық технологиялардың дамуы химиялық зертханалық тәжірибені толықтыруға немесе кей жағдайда ішінара ауыстыруға мүмкіндік беретін жоғары интерактивті және шынайы виртуалды оқу орталарын жасау мүмкіндіктерін кеңейтті.

Бірнеше зерттеу виртуалды зертханалардың студенттердің оқу нәтижелерін жақсартудағы тиімділігін зерттеді. Мысалы, Makransky және т.б. иммерсивті виртуалды шындық зертханаларының студенттердің белсенділігіне әсерін зерттеп, виртуалды зертханалар дәстүрлі оқытумен салыстырғанда мотивация мен ұғымдық түсінікті айтарлықтай жақсартатынын анықтады. Ұқсас түрде, Tatli мен Ayas зерттеуі виртуалды химия зертханаларын пайдаланған студенттердің оқу нәтижелері дәстүрлі зертханаларды пайдаланғандармен салыстырмалы екенін көрсетті, бұл виртуалды орталардың тәжірибелік эксперименттің білім беру артықшылықтарын тиімді қайталай алатынын көрсетеді [3].

Виртуалды лабораториялар студенттерге химиялық реакциялар мен процестерді нақты уақыт режимінде визуалды түрде бақылауға мүмкіндік береді. Олар эксперименттерді қайталап орындау, қателіктерді қауіпсіз тексеру және нәтижелерді талдау арқылы білімді терең меңгеруге ықпал етеді. Сонымен қатар, виртуалды лабораторияларды Web-платформаларға интеграциялау тәжірибелік дағдыларды қашықтықтан оқыту кезінде де тиімді үйретуге мүмкіндік береді [4]. Студенттер браузер арқылы виртуалды құралдар мен симуляцияларды пайдаланып, тәжірибе жасау процесін толық бақылап, деректерді жинап және талдай алады.

Аналитикалық химияда виртуалды лабораториялар ерекше маңызды. Олар студенттерге спектроскопиялық, хроматографиялық, титрлеу және басқа аналитикалық әдістерді виртуалды түрде қолдануға мүмкіндік береді. Мысалы, студент Web-платформадағы виртуалды лабораторияны пайдаланып титрлеу тәжірибесін жүргізе алады, виртуалды бюретка мен индикаторды қолдана отырып, қадамдық нұсқаулармен нәтижелерді тіркейді. Сондай-ақ, спектрофотометрлік өлшеулерді немесе газ-хроматографияны виртуалды түрде симуляциялау арқылы студенттер деректерді жинап, талдауды үйренеді. Бұл тәсіл қауіпсіздік пен ыңғайлылықты қамтамасыз етіп қана қоймай, аналитикалық дағдыларды тиімді дамыта алады.

Зерттеулер көрсеткендей, виртуалды лабораторияларды Web-платформалар арқылы қолдану студенттердің оқу нәтижелерін жақсартуға көмектеседі. Виртуалды тәжірибелер теориялық білімді практикамен үйлестіріп, аналитикалық дағдыларды дамытады. Олар студенттердің белсенділігін арттырады, мотивацияны күшейтеді және қашықтықтан оқыту жағдайында практикалық дайындық деңгейін сақтауға, сонымен қатар, виртуалды лабораторияларды пайдалану қателіктерді қауіпсіз тексеруге және эксперимент нәтижелерін дұрыс талдауға мүмкіндік береді.

Қорыта келгенде, виртуалды химия зертханалары, аналитикалық химияға арналған виртуалды лабораториялар және оларды Web-платформалар арқылы қолдану қашықтықтан оқытудың тиімді құралдары болып табылады. Олар студенттердің теориялық білімін тәжірибелік дағдылармен біріктіріп, зерттеу қабілеттерін дамытады, тәжірибе жасау процесін қауіпсіз және қолжетімді етеді. Виртуалды лабораторияларды Web-платформалар арқылы қолдану оқу процесін заманауи талаптарға сай жетілдіреді, аналитикалық химия бойынша практикалық дайындықты арттырады және студенттердің кәсіби қабілеттерін қалыптастыруға үлкен үлес қосады.

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PRODUCTION AND PROMOTION OF A DIGITAL EDUCATIONAL PLATFORM FOR SCHOOL-AGE CHILDREN USING ARTIFICIAL INTELLIGENCE TECHNOLOGIES: GLOBAL EXPERIENCE AND PROSPECTS IN THE REPUBLIC OF KAZAKHSTAN

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Annotation

The article discusses current issues of the development and marketing of educational platforms (EdTech) for schoolchildren in the era of digital transformation. The analysis of the introduction of artificial intelligence (AI) technologies into the educational process is carried out using the example of global brands (Duolingo, Khan Academy, Byju's). The key trends in the personalization of training are identified. Based on the global analysis, specific strategies for producing content and promoting digital educational products in the market of the Republic of Kazakhstan are proposed, taking into account the socio-cultural, linguistic and technological features of the region.

Keywords: EdTech, artificial intelligence, digital education, personalization, educational services marketing, Kazakhstan, content production, adaptive learning.

Introduction

In the 21st century, the education system is undergoing fundamental changes, moving from a traditional "industrial" model focused on the average student to personalized digital ecosystems. The COVID-19 pandemic acted as a powerful catalyst for the growth of the EdTech (Educational Technology) market, but it also exposed the key problem of distance learning: low student engagement and lack of individual approach in mass education. The solution to this problem is the integration of artificial intelligence (AI) and machine learning (ML) technologies. AI ceases to be just an auxiliary tool and becomes the core of the educational platform, acting as a tutor, methodologist and analyst at the same time. It is important to note that the EdTech market in Kazakhstan in 2023 decreased by 21% (to 52.4 billion tenge), which makes accurate strategic planning critically important. Nevertheless, the children's education segment (K-12) remains the main driver of growth, occupying almost 47% of the market.

For the Republic of Kazakhstan, the development of its own high-tech educational platforms is a strategic objective within the framework of the Digital Kazakhstan state program. Given the gap in the quality of education between urban and rural schools (PISA monitoring), as well as the shortage of high-quality content in the state language, the creation of a domestic EdTech product using AI has high social and commercial potential.

The purpose of this work is to analyze the methods of production and promotion of such platforms, based on the best international experience.

Global Brand Analysis: Artificial Intelligence as a growth driver

The success of the global leaders of the school education market is based on the deep integration of algorithms that allow you to keep the child's attention (Retention Rate) and increase the effectiveness of learning. Let's look at the key cases.

Khan Academy: Democratizing Tutoring

One of the most illustrative examples is Khan Academy and their Khanmigo pilot project based on the GPT-4 language model. Unlike traditional chatbots, Khanmigo does not provide direct answers to tasks. He uses the Socratic dialogue method: he asks leading questions, encouraging the student to come to a decision on his own.

Success Analysis: The platform solves Bloom's "two sigma problem" by proving that individual tutoring is significantly more effective than group tutoring. AI makes this tutoring scalable and cheap.

2.2. Duolingo: Gamification and adaptability

The Duolingo application demonstrates the highest engagement rates (DAU — Daily Active Users) thanks to the sophisticated Bandit algorithms system and the Birdbrain model.

Technology: The algorithm analyzes every user action. If a student makes mistakes too often, the system simplifies assignments to avoid frustration. If the answer is too easy, it increases the difficulty so that you don't get bored.

A lesson for developers: The difficulty balance is maintained automatically. This is critically important for a children's audience, as school-age children have a significantly lower threshold for attention loss than adults.

2.3. Byju's (India): Visualization and scaling

The Indian giant Byju's has relied on high-quality video production (Disney-level animation) in combination with algorithms for building a "knowledge Graph". The system identifies gaps in a student's fundamental knowledge and offers content to address them before moving on with the program.

Conclusion: AI allows you not only to deliver content, but also to diagnose the causes of academic failure, which may be rooted in topics covered several years ago.

3. Digital Platform Production: Technology and Content

Creating a competitive platform for Kazakhstan requires a synergy of technical development and pedagogical design.

3.1. Technological architecture

A modern platform should include three levels of AI:

NLP (Natural Language Processing) for the Kazakh language: This is the main technological barrier and at the same time a point of growth. The platform must correctly process queries in Kazakh, understanding the morphology and context, as well as recognize mixed speech (code-switching), characteristic of the bilingual environment of Kazakhstan.

Recommendation System (RecSys): Based on big data on the behavior of thousands of schoolchildren, the system should build individual Learning Paths. For example, if a student perceives information visually better, the AI will offer more videos and infographics.

Computer Vision: Proctoring technologies can be used to analyze engagement (with parental permission). The camera can record when the child is distracted, and the system will prompt you to pause or change the task format to a game one. Additionally, the CV can analyze emotional states (boredom, frustration) for a more subtle and rapid adaptation of the learning process, which is critically important for a children's audience.

3.2. Producing educational content

The term "producing" in EdTech is different from the film industry. This is the creation of an educational experience (Learning Experience Design).

Micro-learning: The content should be divided into short blocks (3-7 minutes). Long lectures are ineffective for the "Alpha generation".

Localization and cultural code: Simply translating foreign courses is not enough. The production should include the adaptation of scenarios to the Kazakh realities. Math problems should include tenge, cities of Kazakhstan (Almaty, Astana, Shymkent), names of national heroes and understandable cultural references. It is also recommended to integrate gamification and content elements related to national holidays and history, which increases the emotional connection with the product.

4. Promotion and production strategy in the Republic of Kazakhstan

The Kazakhstan market has unique characteristics: a high degree of digitalization (the penetration of smartphones and the Internet), a young population (baby boom) and the cult of education in families.

Despite the high potential, it is necessary to take into account that the volume of the EdTech market in Kazakhstan in 2023 decreased to 52.4 billion tenge, which requires more careful and precise strategic planning.

4.1. Target audience analysis and decision-making model

In the school segment of EdTech, there is a gap between the user and the buyer:

User (User): Kid. Interest, gamification, and the absence of boredom are important to him.

Buyer (Payer): The parent. The result is important to him (grades, UNT, admission to the NIS / BIL) and safety. In addition, there is a pronounced distrust of infobusiness in the market, which requires maximum transparency from the platform and an emphasis on academic expertise and certification.

A marketing strategy should work on two fronts.

4.2. Promotion channels and tactics

Influencer Marketing: Kazakhstan has traditionally had a high level of trust in recommendations. Working with mom bloggers ("mom blogs" on Instagram) and education experts is effective. The key message for parents is: "An AI platform is a tutor who is always there and costs less than a cup of coffee."

Ecosystem approach: Integration or partnership with existing super-applications (for example, through mini-applications within banking ecosystems or partner programs). This lowers the entry barrier and makes it easier to pay for a subscription.

B2G and working with schools: Given the strong role of the state, promotion through pilot projects in schools is a powerful driver. Providing the platform to schools for free (Freemium model for B2B) allows you to collect a user base and, more importantly, data for training AI algorithms. This is a strategic step, as the B2G sector is one of the few legal and scalable ways to collect big data, which is crucial for creating a truly adaptive system.

Social Media and TikTok: To attract children (end users), it is necessary to create viral content on TikTok and YouTube Shorts. These can be educational life hacks, solving problems from the UNT in 30 seconds, and challenges. The production of such content should be in the language of youth, without excessive academicism.

4.3. Language issue as a competitive advantage

There is an acute shortage of high-quality EdTech content in the Kazakh language on the market, especially in the field of STEM (science, technology, engineering, mathematics).

Strategy: Positioning the platform as the first national AI tutor in the Kazakh language. Using generative AI to translate and duplicate the best global content into Kazakh will allow you to quickly fill the platform with high-quality materials, ahead of competitors who create content manually.

5. Conclusion

The production and promotion of a digital educational platform for schoolchildren in Kazakhstan is a complex but promising process that requires the synthesis of advanced technologies and a deep understanding of the local context. The use of artificial intelligence technologies ceases to be a marketing ploy and becomes a prerequisite for the survival of the product. The global experience (Duolingo, Khan Academy) proves that the future belongs to adaptive learning, where the program adapts to the student, and not vice versa.

For the successful implementation of the project in Kazakhstan, it is necessary:

1. Invest in the development of NLP models for the Kazakh language, taking into account bilingualism and mixed speech.
2. Apply product production strategies based on cultural code and micro-learning.
3. Use two-level marketing, working simultaneously with the demands of parents (quality, price, academic expertise) and the interests of children (gamification, content). A key strategic step is to use the B2G channel to collect and validate data that is critical for learning adaptive AI algorithms. The implementation of these approaches will make it possible to create a product that can not only take a leading position in the market, but also make a significant contribution to the development of the country's human capital, ensuring equal access to high-quality education regardless of the student's place of residence.

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Studying real-life situations in biology: The case approach

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To increase students' engagement in biology lessons and help them connect theoretical knowledge with practical situations, various interactive methods are used. One of these methods is the Case technology.

The case-study method is based on the analysis of real or artificially created situations and allows students to relate the knowledge they acquire to the problems they encounter in daily life. The diversity of case examples—practical, instructional, and research-based situations—helps teachers plan lessons appropriately and enables students to apply their knowledge in different contexts. During the application of this method, examples are classified according to their goals and content.

- **Practical case examples** include real-life situations aimed at developing students' ability to solve problems they may encounter in professional activity or everyday life. These examples allow students to analyze real-life situations and make practical decisions. For instance, issues such as soil and water pollution caused by excessive use of pesticides in agriculture or the decline of bee colonies help students understand real ecological and biological problems.
- **Instructional case examples** are artificially created, practice-oriented situations designed for educational and value-based purposes. These examples develop students' skills to express opinions and make judgments on specific topics. Situations focused on social justice, ethical decision-making, or environmental protection contribute to shaping students' values and sense of responsibility.
- **Research case examples** are prepared to obtain new knowledge and are based on scientific methods and approaches. These examples help develop students' abilities to conduct research, propose hypotheses, and generate scientific conclusions. Situations related to biodiversity conservation or the impact of genetic modifications support students in developing scientific thinking and research skills.

The case method helps develop key competencies in biology lessons. It fosters the following essential skills in students:

- Analytical thinking – analyzing problems and identifying cause-and-effect relationships.
- Research skills – observing, collecting data, and drawing conclusions.
- Problem-solving – making decisions and evaluating alternative solutions in real-life situations.
- Critical thinking – evaluating information skeptically and reaching accurate conclusions.
- Collaboration and communication – exchanging ideas and participating in discussions during group work.
- Innovation and creativity – finding and applying new solutions.
- Data analysis and application – adapting theoretical knowledge to practical situations.
- Responsibility and decision-making – being accountable for outcomes and making rational choices.

Let us explore detailed case examples that strengthen students' theoretical knowledge while connecting learning with real life.

Grade: 9

Topic: Genetic Diseases

A 9th-grade student, Rashad, has a neighbor child suffering from thalassemia. The child often goes to the hospital and needs regular blood transfusions. Because of this, he misses classes and becomes easily fatigued. Rashad wonders: *“Why does this disease cause such difficulties and how can we help such children?”*

Tasks:

1. List the main symptoms of thalassemia.
2. Discuss what difficulties people with this disease face in daily life.
3. Suggest ways in which society and schools can support such children.
4. As a group project, prepare a small project titled “Support Program for Children with Thalassemia.”

Grade: 10

Topic: Sources of Infection and Mechanisms of Transmission

In one family, a member is sick with symptoms such as coughing, sore throat, and fever. Other family members frequently interact with this person, which increases their risk of infection.

Question: *“What causes the spread of the disease, and how can infection be prevented?”*

Tasks:

1. List the possible sources of infection.
2. Explain the routes of transmission.
3. Propose measures to prevent infection at home and in daily life.
4. Prepare a group task titled “Daily Rules for Protection Against Infections.”

Thus, the Case technology is an important modern pedagogical approach in the teaching of biology. Its widespread application not only improves the quality of education but also makes the lesson process more engaging and interactive, increases students interest in the subject, and prepares them for future careers and everyday life.

УДК 378.016:57

ЭФФЕКТИВНОСТЬ ИСПОЛЬЗОВАНИЯ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В ПРЕПОДАВАНИИ БИОЛОГИИ В СРЕДНЕЙ ШКОЛЕ

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Аннотация.

В статье рассмотрены возможности и эффективность использования инструментов искусственного интеллекта (ИИ) в преподавании биологии в средней школе. Проанализированы основные направления интеграции ИИ в образовательный процесс: персонализация обучения, интеллектуальная поддержка учителя, развитие исследовательских навыков школьников, моделирование биологических процессов, автоматизация оценивания. На основе анализа литературы и экспериментальных данных сделан вывод о значительном повышении успеваемости, мотивации и качества усвоения биологического материала при систематическом применении ИИ-технологий.

Введение

Развитие цифровых технологий привело к появлению новых образовательных инструментов, среди которых особое место занимает искусственный интеллект. ИИ позволяет автоматизировать рутинные процессы, адаптировать учебный материал под индивидуальные особенности ученика, создавать интерактивные модели и симуляции биологических процессов. В условиях модернизации среднего образования и перехода к компетентностному обучению проблема эффективности использования ИИ в преподавании биологии становится особенно актуальной.

Биология как учебный предмет обладает высоким потенциалом для применения ИИ благодаря наличию сложных процессов, которые трудно объяснить только с помощью традиционных методов: обмен веществ, генетика, эволюция, экология, анатомия человека. Интеллектуальные системы позволяют визуализировать эти процессы, моделировать их и обеспечивать гибкую обратную связь.

Цель работы — определить эффективность использования ИИ в обучении биологии и выявить наиболее результативные направления его применения.

Методы исследования

В ходе исследования применялись следующие методы:

1. **Анализ научной литературы** по теме цифровизации образования и применения ИИ в обучении.

2. **Анкетирование учителей биологии** средней школы (n=42).
3. **Педагогический эксперимент** в 7–9 классах (продолжительность — 8 недель).
4. **Методы математической статистики** для обработки результатов.
5. **Сравнительный анализ успеваемости** учащихся контрольной и экспериментальной групп.

Инструменты ИИ включали: обучающие платформы с элементами адаптивного обучения, чат-боты, системы автоматического оценивания, виртуальные лаборатории и симуляторы, генераторы тестов и заданий, а также мультимодальные модели (например, ChatGPT).

Основная часть

1. Возможности ИИ в преподавании биологии

Использование ИИ позволяет решать широкий спектр педагогических задач:

- **Персонализация образовательного процесса.**
- Интеллектуальные системы подстраивают уровень сложности материала, темп обучения и тип заданий под каждого учащегося. По данным эксперимента, 78% участников сообщили, что обучение стало понятнее благодаря индивидуальным подсказкам и рекомендациям.
- **Интерактивность и моделирование сложных процессов.**
- С помощью ИИ возможно создание виртуальных лабораторий (например, моделирование генетических скрещиваний, наблюдение за митозом и мейозом, изучение экосистем). Это повышает наглядность и способствует формированию навыков исследовательской деятельности.
- **Автоматизация оценивания и генерация обучающих материалов.**
- Учитель получает возможность экономить до 30–40% рабочего времени благодаря автоматической проверке тестов, созданию индивидуальных заданий и анализу ошибок учащихся.
- **Поддержка мотивации.**
- Интерактивные объяснения, мультимодальные ответы и возможности для самостоятельного поиска информации стимулируют познавательную активность школьников.

2. Результаты педагогического эксперимента

В эксперименте приняли участие учащиеся 7–9 классов. Были сформированы две группы:

- **Экспериментальная** — обучение с систематическим использованием ИИ;
- **Контрольная** — традиционное обучение.

Основные результаты:

- **Повышение успеваемости.**
- Средний балл по итоговой диагностике увеличился:
 - в экспериментальной группе — на **23%**,
 - в контрольной — на **7%**.
- **Рост мотивации.**
- 64% учащихся экспериментальной группы отметили, что занятия по биологии стали «интереснее» или «намного интереснее».
- **Развитие исследовательских навыков.**
- На 35% выросла доля учеников, способных самостоятельно строить гипотезы и проводить мини-исследования с использованием виртуальных лабораторий.
- **Повышение качества усвоения сложных тем.**
- Наиболее заметный эффект наблюдался при изучении разделов:
 - генетика,

- клеточная биология,
- экология (моделирование пищевых цепей и экосистем).

3. Трудности и ограничения использования ИИ

Несмотря на высокую эффективность, выявлены и проблемы:

- **Недостаточная цифровая грамотность некоторых учителей.**
- **Технические ограничения школ** (скорость интернета, отсутствие оборудования).
- **Риск перегрузки учащихся информацией** при неправильной интеграции инструментов.
- **Необходимость методической подготовки** для корректного применения ИИ на уроках биологии.

Эти факторы требуют системного подхода и поддержки педагогов.

Обсуждение

Полученные результаты подтверждают, что ИИ способен стать мощным инструментом повышения качества биологического образования. Он расширяет традиционные методы преподавания, обеспечивает гибкость и вариативность учебного процесса, усиливает практическую направленность предмета.

Однако эффективность ИИ зависит от грамотной методики применения, сочетания инноваций с традиционными формами обучения и готовности учителя адаптироваться к новым технологическим условиям.

Заключение

Применение искусственного интеллекта в преподавании биологии в средней школе является эффективным инструментом повышения качества обучения. ИИ позволяет персонализировать процесс обучения, формировать исследовательские компетенции, улучшать понимание сложных биологических процессов и повышать мотивацию учащихся.

Результаты педагогического эксперимента подтверждают, что систематическое использование ИИ приводит к значительному росту успеваемости и вовлечённости школьников.

В будущем рекомендуется расширить сферу применения ИИ в биологическом образовании, разработать методические материалы для учителей и обеспечить школам необходимую техническую базу.

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Химия сабақтарында тең мүмкіндіктерді қамтамасыз етуге бағытталған болашақ мұғалімдердің кәсіби құзыреттілігін қалыптастыру стратегиялары

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Аңдатпа. Инклюзивті білім беру – қазіргі білім саласындағы ең маңызды жетістіктердің бірі. Оның негізгі мақсаты – оқыту мен тәрбиелеу үдерісінде әрбір оқушының ерекшелігін ескеретін, қолжетімді әрі кедергісіз білім беру ортасын қалыптастыру. Әсіресе орта мектеп деңгейінде Жаратылыстану ғылымдары, соның ішінде химия пәні, мазмұнының теориялық күрделілігі мен тәжірибелік сипатынан туындайтын ерекше қиындықтарды қамтиды. Сондықтан оқу бағдарламаларын бейімдеу мен оқыту әдістемелерін өзгерту – мүмкіндігі шектеулі оқушылардың пәнді тең деңгейде меңгеруіне жағдай жасау үшін қажетті қадам. Бұл педагогикалық тәжірибені шынайы инклюзивті мүмкіндіктерге айналдырады. Әсіресе химия секілді тәжірибелік және күрделі пәнді оқытуда мұғалімнің кәсіби, психологиялық және әдістемелік дайындығы маңызды рөл атқарады.

Осы мақалада болашақ химия мұғалімдерін инклюзивті білім беру жағдайында даярлау ерекшеліктері қарастырылады. Зерттеудің өзектілігі – инклюзивті білім беру талаптарына сәйкес педагогикалық кадрларды даярлаудың жаңа модельдерін, әдістерін және құралдарын әзірлеу қажеттілігімен айқындалады.

Кілт сөздер: инклюзив, химия, білім беру, әдістеме, психология.

Стратегии формирования профессиональной компетентности будущих учителей, направленные на обеспечение равных возможностей на уроках химии

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Аннотация. Инклюзивное образование является одним из важнейших достижений современной системы обучения. Его основная цель — создание доступной и безбарьерной образовательной среды, учитывающей особенности каждого учащегося в процессе обучения и воспитания. Особенно на уровне средней школы естественно-научные дисциплины, включая химию, представляют собой определённые трудности из-за теоретической сложности содержания и практико-ориентированного характера предмета. Поэтому адаптация учебных программ и изменение методик преподавания являются

необходимыми шагами для обеспечения равных условий изучения предмета для обучающихся с особыми образовательными потребностями. Это позволяет превратить педагогическую практику в действительно инклюзивную. В преподавании таких сложных и экспериментальных дисциплин, как химия, профессиональная, психологическая и методическая готовность учителя играет ключевую роль.

В данной статье рассматриваются особенности подготовки будущих учителей химии к работе в условиях инклюзивного образования. Актуальность исследования определяется необходимостью разработки новых моделей, методов и инструментов подготовки педагогических кадров в соответствии с требованиями инклюзивного обучения.

Ключевые слова: инклюзия, химия, образование, методика, психология, модель.

Strategies for developing the professional competence of future chemistry teachers aimed at ensuring equal opportunities in chemistry lessons

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Abstract. Inclusive education is one of the most significant achievements of the modern educational system. Its main goal is to create an accessible and barrier-free learning environment that takes into account the individual characteristics of every student throughout the teaching and learning process. At the secondary school level, natural science subjects, including chemistry, present particular challenges due to the theoretical complexity of the content and the practical, experiment-based nature of the discipline. Therefore, adapting curricula and modifying teaching methods are essential steps to ensure equal learning opportunities for students with special educational needs. This transforms pedagogical practice into genuinely inclusive learning. In teaching complex and experimentally oriented subjects such as chemistry, the professional, psychological, and methodological preparedness of the teacher plays a crucial role.

This article examines the specific features of preparing future chemistry teachers to work in inclusive educational settings. The relevance of the study is determined by the need to develop new models, methods, and tools for training teaching staff in accordance with the requirements of inclusive education.

Keywords: inclusion, chemistry, education, methodology, psychology.

Кіріспе. Инклюзивті білім беру – барлық балалардың жеке ерекшеліктеріне қарамастан, біртұтас білім беру ортасында білім алуына мүмкіндік беретін педагогикалық концепция. Химия пәнін оқыту үдерісінде инклюзивтілік әрбір оқушының ерекшелігін ескеретін, тең мүмкіндіктерді қолдайтын және тұлғалық дамуын ынталандыратын білім беру ортасын құруды көздейді. Бұл ұғым тек оқу бағдарламасын бейімдеумен шектелмей, оқыту үдерісіне педагогикалық, құрылымдық және мәдени өзгерістерді енгізуді талап етеді. Мұндай өзгерістер инклюзивті ортада құрмет пен қолжетімділіктің толық іске асырылуының негізгі шарты болып табылады.

Осы тұрғыдан алғанда, инклюзивті білім беруді дамытуда мұғалімдерді кәсіби даярлау мәселесіне бағытталған мемлекеттік саясаттың өзектілігі арта түсуде. Мемлекеттік деңгейде мұғалімдердің бастапқы кәсіби даярлықтан бастап, үздіксіз білім жетілдіру бағдарламаларына қолжетімділігін қамтамасыз ету маңызды. Мұндай бағдарламалар педагогтарды мектептегі әртүрлілікпен жұмыс жүргізуге, инклюзивті педагогикалық

тәсілдерді тиімді қолдануға және көмекші технологияларды оқу үдерісіне мақсатты түрде енгізуге дайындайды.

Үздіксіз кәсіби қолдау мен жүйелі дайындық мұғалімдердің инклюзивті білім берудегі күрделі міндеттерге жауап беруіне, сондай-ақ барлық оқушылардың сапалы білім алуына жағдай жасауына мүмкіндік береді.

Химия пәнін оқытуда инклюзивті тәсіл оқушылардың әртүрлі қажеттіліктерін ескеріп, тәжірибелер мен зертханалық жұмыстардың қауіпсіздігін қамтамасыз ету, оқу құралдарын бейімдеу және визуалды-дидактикалық материалдарды молынан қолдануды талап етеді.

UNESCO ұсынған «Баршаға арналған білім» тұжырымдамасы барлық балаларға, олардың қабілеттері мен әлеуметтік ерекшеліктеріне қарамастан, сапалы білім берудің маңыздылығын айқындайды. Бұл жаһандық бастама теңдікті қамтамасыз етуге және білім алуға қол жеткізуді шектейтін тосқауылдарды жоюға бағытталған. Индонезияда инклюзивті білім беру 2009 жылғы №70 Заңмен бекітілген, онда инклюзивті білім беру – ерекше білім беру қажеттіліктері бар оқушылар мен ерекше қабілетті балаларды жалпы білім беру ортасына біріктіретін жүйе ретінде анықталған. Бұл тәсіл теңдікті қамтамасыз етуге және инклюзивтілікті нығайтуға бағытталған, сондай-ақ мүмкіндігі шектеулі балалардың азамат ретінде өздерінің негізгі құқықтарын толық жүзеге асыруына мүмкіндік береді [1].

Ынтымақтастық оқу үдерісін дараландыру мен сабақ құрылымын бейімдеу барысында ерекше қажеттіліктері бар оқушылардың қажеттіліктерін барынша ескеруге мүмкіндік береді. Инклюзивті мектептердегі оқыту үдерісі пән мұғалімдері, сынып жетекшілері және тьютор-мұғалімдердің бірлескен қызметі арқылы жүзеге асады. Әрбір маман мүмкіндігі шектеулі оқушылардың оқу барысында кездесетін нақты қиындықтарын жеңілдетуде маңызды рөл атқарады.

Дегенмен, мұғалімдердің инклюзивті білім беру саласындағы дайындық деңгейінің жеткіліксіздігі, оқу ресурстарының шектеулігі және институционалдық қолдаудың әлсіздігі сияқты мәселелер бұл процестің толық жүзеге асырылуына кедергі келтіруде.

Silva мен Amaral зерттеулерінде инклюзивті химия пәнін оқыту бірқатар қиындықтарға тап болатыны атап өтіледі. Солардың ішінде бірінші кезекте мектептердің физикалық инфрақұрылымының жеткіліксіздігі көрсетіледі. Тиісті зертханалық жағдайдың болмауы химия пәнінде аса маңызды болып саналатын тәжірибелік сабақтарды толық көлемде өткізуге кедергі жасайды. Бұған қоса, қарым-қатынас пен көзқарасқа байланысты кедергілер де байқалады: кейбір мұғалімдердің инклюзивті тәжірибені қабылдауға құлықсыздығы, арнайы дайындықтың жоқтығы және мүмкіндігі шектеулі оқушылардың қабілетіне қатысты қалыптасқан теріс стереотиптер оқу процесіне кері әсер етеді [2].

Santos және әріптестері визуалды материалдарды — диаграммалар, иллюстрациялар, түсіндірме бейнероликтер — қолдану химияны меңгеру үдерісін анағұрлым тартымды және қолжетімді ететінін атап өтеді. Оқушылардың мүмкіндіктеріне бейімделген қарапайым әрі жеңілдетілген тәжірибелік жұмыстар химиялық ұғымдарды нақты, тәжірибелік деңгейде түсінуге жағдай жасайды. Сондықтан педагогикалық тәсіл әр оқушының жеке оқу қарқынын ескеріп, өзін қауіпсіз әрі қолдаулы сезінетін орта қалыптастыруы тиіс. Мұндай орта оқушылардың оқу үдерісіне белсенді араласуына және өз мүмкіндігін ашуына ықпал етеді.

Осы тұста Amato мен Ribeiro «Оқытудың әмбебап дизайны» (UDL) тұжырымдамасын инклюзивті химия оқытуда жаңашыл әрі тиімді стратегия ретінде ұсынады. UDL бастапқы кезеңнен-ақ барлық оқушының қажеттіліктерін ескеретін икемді оқу бағдарламаларын жасауды көздейді. Бұл тәсіл оқу барысындағы тосқауылдарды алдын ала жоюға және ақпаратты қабылдау мен меңгерудің бірнеше жолын ұсынуға мүмкіндік береді. Бұл тәсіл үш негізгі принципке негізделген: ақпаратты түрлі тәсілдермен ұсыну, әрекет пен ойды білдірудің әртүрлі жолдарын қамтамасыз ету, сондай-ақ оқуға қызығушылық пен қатысуды

арттыру. Химия пәнін оқытуда бұл принциптер әртүрлі тәсілдер арқылы жүзеге асырылып, оқыту стратегияларын әртараптандыруға және мазмұнның барлық студенттерге қолжетімді болуын қамтамасыз етуге мүмкіндік береді.

UDL тәсілін қолданғанда, мұғалімдер химия мазмұнын түрлі ресурстар мен тілдер арқылы ұсына алады. Мысалы, тактильді материалдар, аудио сипаттамалар, субтитрлі бейнелер және практикалық проекциялар. Көру қабілеті бұзылған студенттер үшін молекулалардың үшөлшемді үлгілері мен периодтық кестенің тактильді нұсқалары сияқты арнайы материалдар олардың түсінуіне көмектеседі. Сол сияқты, есту қабілеті бұзылған студенттер субтитрлері бар бейнелерден, ымдау тілі аудармашыларынан және ауызша түсіндірудің орнын басатын егжей-тегжейлі көрнекі материалдардан пайда көреді. Интеллектуалдық дамуында ерекшелігі бар студенттер үшін ойын әрекеттері, білім беру ойындары және қарапайым тәжірибелер объективті және контекстіленген түсіндірулермен бірге оқу үдерісін жеңілдететін тиімді құрал болып табылады [3].

Болашақ химия мұғалімдері үшін инклюзивті білім беру жағдайында кәсіби даярлықты арттырудың маңызды бағыттарының бірі – инклюзивті білім мәселелері қарастырылатын түрлі симпозиумдарға, семинарларға, конференцияларға қатысу. Мұндай кәсіби ортада талқыланатын ойлар мен тәжірибелер студенттердің инклюзивті оқытуды терең түсінуіне және педагогикалық шеберлігін дамытуына ықпал етеді.

Осыған ұқсас оң әсерді тақырыптық пікірталас формалары — оның ішінде дөңгелек үстел жұмысы да береді. Бұл іс-шараларға ерекше білім беру қажеттіліктері бар балалармен жұмыс тәжірибесі бар, арнайы дайындықтан өткен білікті мамандар шақырылады. Олар алдын ала әзірленген баяндамалар мен хабарламалар арқылы инклюзивті білім берудің өзекті мәселелерін ұсынады. Кейін пікірталас кезеңі басталып, талдау, түсініктеме беру, ой алмасу жүзеге асады. Мұндай формат болашақ педагогтардың кәсіби көкжиегін кеңейтіп қана қоймай, сындарлы пікір айту және қабылдау дағдыларын дамытады.

Оқыту барысында техникалық құралдарды, мерзімді басылым материалдарын, диаграммалар мен көрнекі мысалдарды, бейнематериалдарды кеңінен қолдану да тиімді. Олар оқу процесін визуалды тұрғыдан қолжетімді етіп, ақпаратты жеңіл қабылдауға мүмкіндік береді [4].

Мастер-класс та кәсіби дамудың заманауи әрі тиімді формаларының бірі болып саналады. Бұл форматта білім жетілдіру курстарының тыңдаушылары әртүрлі әдістер мен технологияларды практикада қолдану дағдыларын пысықтайды, кәсіби деңгейін арттыруға және қатысушылар арасында тәжірибе алмасуға мүмкіндік алады. Мастер-класс барысында студенттер жаңа технологиялармен, авторлық әдістемелермен және үздік педагогикалық практикалармен танысады, бұл олардың болашақ кәсіби қызметінде маңызды рөл атқарады.

Мұғалімдерге қолдау көрсету мен тәлімгерлікті сипаттайтын кеңес берудің үш моделі бар.

1. Интервенциялық модель. Бұл үлгіде тәжірибелі мұғалім жетекші және бағыттаушы рөл атқарады. Ақпаратты беру басым болып, білім мен дағдыларды түсіндіру және қолдану алдыңғы қатарға шығады. Мұнда мұғалімнің міндеті — нақты нұсқаулық беру.

2. Кеңесшілік (ассистивті) модель. Бұл жағдайда тәжірибелі мұғалім кеңесші ретінде әрекет етеді. Оның жаңа маманмен байланысы ұсыныс жасау, қолдау көрсету және түсіндіру арқылы жүзеге асады. Тәжірибелі педагог қажетті материалдарды ұсынып, ұғымдарды талқылау мен қарастыруға жағдай жасайды. Ол шешім қабылдау үдерісін үйлестіруші әрі бақылаушы рөлін таңдайды. Бұл модель кәсіби қызметтің интерактивті әдістемесіне негізделіп, үдерістер мен әрекеттердің сапасын арттыруға бағытталған.

3. Ынтымақтастық моделі. Бұл үлгіде тәжірибелі мұғалім сындарлы пікір білдіруші әріптес ретінде көрінеді. Екі тараптың өзара тәуелділігі мен серіктестігі олардың кәсіби өсуінің

негізіне айналады. Ортақ жауапкершілік, тәжірибе алмасу, пікір алмасу жүзеге асырылады. Материалдар мен идеялар бірлесе әзірленеді.

Шығармашылық топтың әдістемелік-кәсіби қызметінің нәтижесі – жас мұғалімдердің шығармашылық белсенділігін қалыптастыру, бастамашылдығын дамыту және олардың кәсіби беделінің артуы [5].

Мұғалімдердің кәсіби құзыреттілігі инклюзивті білім берудің табысты іске асуына шешуші әсер ететіні анық. Кәсіби даму бағдарламалары, тәжірибе алмасу алаңдары, семинарлар, шеберлік сабақтары және инклюзивті педагогиканың теориялық негіздерін меңгеру мұғалімдердің оқу үдерісін тиімді жоспарлауына, оқушылардың жеке қажеттіліктерін ескеріп оқытуына мүмкіндік береді. Инклюзивті химия оқытуды жетілдіру үшін келесі бағыттар ұсынылады:

1. Мұғалімдерге арналған тұрақты кәсіби даму және инклюзивті білім бойынша арнайы курстарды күшейту;
2. Адаптивті және қолжетімді оқу құралдарын, цифрлық қосымшалар мен тактильді модельдерді әзірлеу;
3. Мектеп саясатын shadow teacher-дің сабаққа тұрақты қатысуын қамтамасыз ететіндей икемдеу;
4. UDL қағидаларына негізделген икемді оқу бағдарламаларын енгізу [6].

Көмекші технологиялар – 3D модельдер, Брайль материалдары, дыбыстық сипаттамалар, субтитрлі немесе ымдау-тілді түсіндірмелері бар видеолар – оқушылардың оқу үдерісіне толыққанды қатысуына мүмкіндік береді [7].

Қорытынды. Инклюзивті білім беру – барлық оқушыларға тең және сапалы білім алуға мүмкіндік беруді көздейтін заманауи білім беру саясатының маңызды бағыты. Химия пәнін инклюзивті ортада оқыту ерекше тәсілдерді, оқыту материалдарын бейімдеуді, сондай-ақ мұғалімдердің кәсіби даярлығын күшейтуді талап етеді. Химия ғылымының абстрактілі ұғымдары, символдық тілі және тәжірибелік сипаттағы тапсырмалары ерекше білім берілуіне қажеттілігі бар оқушылар үшін қосымша қиындықтар туғызатындықтан, оқу мазмұнын икемдеу және әдістемелерді бейімдеу аса маңызды міндет болып табылады.

Химияны инклюзивті оқыту барысында оқу материалын жеңілдету, визуалды және тактильді құралдарды қолдану, тәжірибелерді қауіпсіз әрі қолжетімді форматта ұйымдастыру, сондай-ақ оқушылардың жеке оқу қарқынын ескеру қажет. UDL (Universal Design for Learning) қағидастарына негізделген оқыту барлық оқушыларға түсінуге, қатысуға және өз білімін әртүрлі формада көрсетуге мүмкіндік береді. Бұл тәсіл инклюзивті білім беру сапасын арттырудың тиімді жолдарының бірі болып табылады.

Инклюзивті ортада жұмыс істейтін химия мұғалімдерінің кәсіби құзыреттілігі ерекше рөл атқарады. Мұғалім тек сабақ беруші емес, әр оқушының қажеттілігін байқап, қолдау көрсететін, оқыту процесін бейімдей алатын маман болуы қажет. Осыған байланысты мұғалімдердің арнайы педагогика, көмекші технологиялар, адаптивті оқыту әдістері бойынша білімін жетілдіру – инклюзивті химия оқытудың негізгі шарттарының бірі. Сонымен қатар, мұғалім мен тьютор/ассистент арасындағы өзара байланыс оқыту процесінің тиімділігін арттырады.

Қолайлы оқу ортасын құру, бейімделген құралдармен қамтамасыз ету, қолжетімді оқу материалдарын әзірлеу және мектеп әкімшілігінің қолдауы – инклюзивті химия сабақтарының табысты жүзеге асуына ықпал ететін маңызды факторлар. Химия пәнін инклюзивті форматта оқыту тек мінез-құлқ немесе академиялық мақсаттарды ғана емес, оқушылардың әлеуметтік бейімделуін, ғылыми сауаттылығын және өзіндік сенімін қалыптастыруға бағытталуы тиіс.

Қорытындылай келе, инклюзивті химия оқытудың басты мақсаты – әрбір оқушының мүмкіндіктерін кеңейту, оқу үдерісіне толыққанды қатысуына жағдай жасау және барлығына

тең білім алу құқығын қамтамасыз ету. Бұл мақсатқа жету үшін оқу мазмұнын бейімдеу, практикалық және теориялық материалды қолжетімді ету, мұғалімдердің кәсіби дамуымен қатар, оқу ортасының құрылымдық және әдістемелік дайындығы қажет. Инклюзия – тек міндет емес, білім берудегі әділеттілік пен сапаның көрсеткіші.

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DEVELOPING PRIMARY SCHOOL STUDENTS' CREATIVITY THROUGH THE USE OF ARTIFICIAL INTELLIGENCE IN FOREIGN LANGUAGE LESSONS

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This article examines how artificial intelligence technologies can be used to foster creativity among primary school pupils in English as a Foreign Language (EFL) lessons. The aim of the study is to provide a theoretical rationale and methodological description of ways to integrate generative AI tools such as ChatGPT and DALL·E into classroom practice, drawing on recent empirical research and contemporary pedagogical frameworks. The paper identifies several groups of AI-supported practices, including AI-assisted story writing and narrative tasks, multimodal (text-image) storytelling with AI-generated visuals, role-play and dialogic activities with AI as a conversational partner, and the use of teacher-oriented platforms to design open-ended creative tasks. The analysis suggests that, when accompanied by careful pedagogical guidance, these approaches can enhance pupils' fluency and originality in language production, strengthen their motivation and creative self-efficacy, while also raising important questions about overreliance on AI and the mechanisation of creativity, for which strategies to mitigate potential risks and directions for future research are proposed.

Keywords: Artificial intelligence; reativity; primary education; English as a Foreign Language (EFL); multimodal learning; storytelling; digital pedagogy

РАЗВИТИЕ ТВОРЧЕСКИХ СПОСОБНОСТЕЙ УЧАЩИХСЯ НАЧАЛЬНОЙ ШКОЛЫ С ПОМОЩЬЮ ТЕХНОЛОГИЙ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА НА УРОКАХ ИНОСТРАННОГО ЯЗЫКА

В статье рассматриваются возможности использования технологий искусственного интеллекта для развития творческих способностей учащихся начальной школы на уроках английского языка как иностранного. Цель исследования – теоретически обосновать и методически сипатать способы интеграции генеративного ИИ (ChatGPT, DALL·E и др.) в учебный процесс на основе анализа современных эмпирических работ и педагогических подходов. Выделяются основные направления работы: ИИ-поддерживаемое сочинение и сторителлинг, мультимодальное (текстово-визуальное) повествование с использованием сгенерированных изображений, ролевые и диалоговые формы взаимодействия с ИИ, а также применение teacher-oriented платформ для конструирования открытых творческих заданий. Показано, что при наличии продуманного педагогического сопровождения такие формы работы повышают беглость и оригинальность высказывания, мотивацию и уверенность детей в собственных творческих возможностях, одновременно обозначаются риски зависимости от ИИ и снижения доли самостоятельного творчества, а также предлагаются пути их минимизации и направления дальнейших исследований.

Ключевые слова: Искусственный интеллект; творческие способности; начальная школа; обучение английскому языку; мультимодальное обучение; сторителлинг; цифровая педагогика

Introduction

Today, the education system is developing under conditions of intensive digitalization. Artificial intelligence (AI), digital platforms, and smart devices have become an integral part of everyday school learning. The primary school stage is a crucial period during which the child's personality, cognitive skills, and creative potential actively develop. At this stage, it is essential not only to provide linguistic knowledge but also to nurture imagination, independent thinking, and the ability to generate new ideas. Foreign language lessons offer young learners an opportunity to view the world from a different perspective and express their thoughts freely in a new language. However, traditional drills and pattern-based repetition may reduce children's motivation and restrict their creative engagement. In such cases, integrating artificial intelligence tools such as text generation, image creation, dialogue modeling, and more into the learning process can make language lessons more engaging, interactive, and creativity-oriented. Therefore, examining how artificial intelligence can be used to enhance creativity among primary school pupils in foreign language lessons represents a timely and practically significant research direction aligned with modern educational demands.

Developing creativity in primary school pupils is one of the key objectives of modern primary education. In their study, Suyunov and Jabborova emphasize that creativity in early learners is closely linked to imagination, flexible thinking, and problem-solving skills [1]. The authors state that fostering creativity in primary school requires the use of imagination-based tasks, drawing, storytelling, and problem-based activities. They also highlight that globalization and digitalization in education necessitate the integration of innovative teaching methods. Colorful visual materials, non-traditional techniques, engaging games, and problem-solving tasks enable children to generate multiple ideas and express themselves freely [1].

One of the significant conclusions drawn by Suyunov and Jabborova is that teacher creativity directly influences pupil creativity [1]. Teachers who use creative approaches, pose open-ended questions, and encourage independent thinking naturally stimulate the creative potential of young learners. Activities such as brainstorming, drawing, narrating, and thematic discussions contribute to the formation of creative thinking among primary school pupils. While Suyunov and Jabborova focus on traditional and innovative pedagogical methods, recent studies suggest that artificial intelligence can further strengthen this process, especially in foreign language lessons [1]. Crompton notes that AI tools offer age-appropriate multimodal materials (images, audio, stories), interactive feedback, and adaptive tasks tailored to the learner's level. These features increase pupils' creative engagement and motivation to experiment with language [2].

Crompton identifies idea generation support as one of the most valuable advantages of AI. AI helps children overcome "creative blocks" by providing story starters, new vocabulary, scenes, or visual prompts [2]. These features align well with the creativity-enhancing methods described by Suyunov and Jabborova [1], suggesting that AI complements rather than replaces traditional pedagogical approaches.

Chen et al. who explored AI integration in education more broadly, argue that AI improves learning through personalization, adaptive feedback, and intelligent content generation [3]. Their review highlights the evolution of AI systems from simple programs to advanced intelligent tutoring systems capable of performing some of the teacher's functions [3]. Such systems adapt tasks to learners' needs and provide real-time support, creating favorable conditions for developing creativity.

Kostka and Tonselli in their research focused on foreign language teaching, emphasize the importance of generative AI - especially models like ChatGPT in supporting creativity [4]. According to the authors, AI can help students generate ideas, construct stories, write dialogues, and create culturally meaningful texts. They argue that AI can act as a “creative partner,” offering initial ideas that pupils can expand using their own imagination [4]. However, the researchers also highlight several challenges. Crompton notes that AI may occasionally produce overly simplistic language, misinformation, or culturally inappropriate content, requiring teacher oversight [2]. Kostka and Tonselli raise concerns about academic integrity, over-reliance on AI, and the need for digital literacy and critical use skills [4]. Chen et al. emphasize issues related to data privacy, algorithmic fairness, and ethical considerations [3].

Despite these challenges, all researchers agree that AI should not replace teachers but serve as a tool to support pupils’ creative and linguistic development. When used appropriately, AI provides opportunities for personalized creative tasks, idea generation, and enriching foreign language instruction.

Overall, traditional creativity-enhancing pedagogical methods [1] and modern AI tools [2-4] complement each other. The studies consistently show that using AI in foreign language lessons can effectively enhance primary school pupils’ creative thinking, encourage linguistic experimentation, and foster confident and expressive communication.

MAIN PART

1. Theoretical Section

In primary education, creativity is often understood as pupils’ ability to generate new and meaningful ideas by combining imagination, experience, and personal interpretation. Scholars emphasize that creativity is not a rare talent possessed only by a few gifted children; rather, it is a natural potential that manifests in every learner to varying degrees [5]. Runco stresses that creativity should not be viewed solely as a high-level, visible product but as a process of personal meaning-making that occurs in a child’s everyday life [5]. Primary school children frequently express their creativity through play, imaginative activities, drawing, storytelling, and free associations. These processes also play an important role in foreign language learning, as imagination and flexible thinking allow children to construct new meaning even with a limited linguistic repertoire.

In the context of English as a Foreign Language (EFL), creativity is closely linked to the learner’s ability to use limited vocabulary and basic grammatical structures in flexible ways. The fewer linguistic resources children have, the more they need to find alternative solutions, combine familiar words in new ways, and explore different ways of expressing their ideas. In this sense, creativity and foreign language learning complement each other. Furthermore, fostering creativity is an essential component of 21st-century skills such as critical thinking, problem-solving, communication, and adaptability which are crucial for successful language acquisition.

Traditionally, teachers develop creativity in primary school through activities such as free writing, picture-based storytelling, role-playing, and dialogue improvisation. These tasks enable learners to generate ideas, construct personal meaning, and speak freely. Creativity is viewed not as an isolated individual ability but as a process shaped through social interaction [6]. When pupils build on each other’s ideas, co-construct meaning, and collaboratively develop a story, the social dimension of creativity becomes more pronounced. The teacher’s role is to maintain a balance between providing freedom and structuring the task, ensuring purposeful and effective learning [6].

However, traditional creative tasks may present challenges for some learners. Limited vocabulary, difficulty generating ideas, or fear of making mistakes can reduce children’s creative engagement. In recent years, artificial intelligence (AI) has been increasingly explored as a means

of addressing such issues in foreign language lessons [2-4]. AI includes systems that can automatically generate texts, dialogues, images, and various linguistic patterns.

AI offers several advantages in primary school EFL lessons. First, it can provide linguistic support by generating simple example sentences, descriptions, or short phrases with new vocabulary making it easier for children to create texts [3,4]. Second, AI can function as a story starter by generating the beginning of a narrative, characters, or a conflict. This helps overcome the common difficulty of “Where do I start?” when engaging in creative tasks [2,4]. Such support aligns with Runco’s concept of personal meaning-making [5], as AI provides the initial idea while the learner constructs the main content of the story.

Third, AI can generate visual materials - fantasy illustrations, unique characters, or new settings that pupils can use for storytelling, descriptive writing, or role-play activities [2]. These external tools act as mediating resources that support creative development, consistent with socio-cultural theory [5]. Additionally, through chatbots, pupils can practice simple dialogues without fear of making mistakes. The immediacy of AI responses keeps learners engaged and encourages linguistic experimentation [3,4].

However, studies stress that the effectiveness of AI depends entirely on appropriate pedagogical organization [2-4]. AI should not replace the teacher but enhance their work. The teacher designs open-ended, multi-solution tasks; facilitates discussions around AI-generated ideas; and guides pupils towards meaningful outcomes [2,5]. When these conditions are met, AI enriches traditional methods and supports the simultaneous development of linguistic and creative abilities. Overall, theoretical foundations indicate that artificial intelligence can effectively support creativity in primary school English lessons [2-4]. It helps learners generate ideas, construct new meaning, collaborate, and express themselves freely. When implemented thoughtfully, AI becomes a powerful tool for unlocking each pupil’s creative potential.

2. Methodology

The integration of artificial intelligence in primary school English lessons is viewed not merely as a technological innovation but as a new pedagogical approach to developing pupils’ creativity. AI functions not only as a tool for revisiting linguistic structures but also as a collaborative partner that enables learners to develop ideas freely, activate imagination, and enrich narratives both semantically and linguistically. Recent scholarly research provides strong evidence that AI can be used effectively to foster creativity in early-stage foreign language learning.

For example, in an experiment conducted by Kızıldağ (2025), fourth-grade pupils who worked with ChatGPT demonstrated significantly higher quality in creative writing and stronger writing self-efficacy compared to peers who used traditional methods [7]. These findings indicate that AI influences learners not only as a linguistic support tool but also as a stimulus for creative thinking.

AI-based creative tasks are especially visible in narrative-oriented activities such as story creation, fairy-tale writing, and plot development. Platforms such as ChatGPT, StoryWizard, and StoryBee allow pupils to co-construct fictional characters, settings, timelines, and plot sequences. When teachers ask learners to analyze AI-generated texts, add their own ideas, modify a proposed storyline, or continue it, pupils do not simply copy the ready-made material; instead, they learn to make independent decisions and apply creative transformations. This approach enhances pupils’ engagement in conceptualizing plot structures, developing cognitive flexibility, and generating alternative solutions. Woo et al. (2023) and colleagues describe methodological approaches for using NLG tools in tasks aimed at developing students’ ideas, highlighting the effectiveness of comparing multiple versions and modifying content. [8].

Another important direction in which AI supports creativity at the primary level is the use of multimodal tools. Since children’s imagination is often closely linked to visual experience,

image-generation systems such as DALL·E play an important role in helping pupils visualize stories, imagine scenes, and structure narrative elements. Research on multimodal storytelling methods shows that illustrations are presented as supportive tools that help learners structure narratives and enrich their content [9]. AI-generated illustrations also facilitate the organization of stories into beginning, development, climax, resolution, while expanding learners' vocabulary. Experimental data indicate that groups working with AI showed higher creative performance, which demonstrates that AI can effectively support the creative process [10]. This indirectly suggests that AI can amplify creativity not only in older learners but also among primary school pupils with similar cognitive needs.

AI also plays a notable role in fostering creativity in oral language production. In role-play activities, AI becomes an authentic dialogue partner for young learners. Through roles such as “magic shop owner,” “alien visitor,” or “future self,” children practice communicating freely in English, interacting with imagined characters, and constructing improvised dialogues. Such tasks not only increase pupils' speaking confidence but also strengthen their ability to engage in linguistic improvisation. In a study by Wieland et al. (2022), students produced a greater quantity and diversity of ideas during AI-supported ideation phases [11]. These findings highlight the value of using AI in safe, teacher-controlled formats to support the development of oral creativity in young learners.

Furthermore, AI serves as an effective creative tool not only for learners but also for teachers. Educational platforms such as Twee, LittleLit, and MagicSchool AI help teachers generate creative tasks, open-ended questions, story starters, alternative plotlines, and interdisciplinary mini-projects. In a systematic review examining the integration of AI into ESL/EFL instruction, Lo et al. (2024) found that teachers benefited not only from time savings but also from the enhanced creative quality of the tasks they provided to learners [12]. Data from the PDF similarly show that AI-enriched learning environments increase pupils' motivation, engagement, and confidence in task completion. This further demonstrates that AI is a powerful supplementary tool for developing creativity at the primary level.

However, despite its broad potential, the pedagogical use of AI requires careful guidance. Sharma et al. (2025) caution that early overreliance on AI may limit pupils' initial ideas, while Smith (2003) demonstrated that the “first suggested idea” can restrict the breadth of creative exploration due to cognitive anchoring effects [13]. Therefore, AI use in primary classrooms must always be accompanied by teacher mediation: learners should be guided to revise, alter, critique, and compare AI-generated outputs rather than accepting them uncritically. This approach prevents overdependence on AI and preserves creative autonomy.

In summary, the use of artificial intelligence in primary school English lessons opens new possibilities for creativity development. Story construction, visual storytelling, role-play, and teacher-focused creative platforms all become modern methods that, when properly implemented, expand children's imagination, enhance linguistic potential, and cultivate critical and creative thinking. Using AI as a tool that strengthens rather than replaces learners' independent thinking is one of the central tasks of contemporary language pedagogy.

3. Analysis and Results

This section presents the findings on the use of artificial intelligence (AI) tools for fostering creativity among primary school pupils in English language lessons. Based on the literature review and empirical studies, the effectiveness of AI in developing creative abilities is demonstrated. Overall, lessons incorporating AI showed noticeable improvements in pupils' creative writing skills. In a study involving ChatGPT-based writing tasks, the experimental group demonstrated significant gains across three dimensions of creativity fluency, originality, and elaboration. The TTCT scores of the experimental group were 15.2% higher compared to the

control group. These results indicate that AI serves as an effective tool for enhancing pupils' attitudes toward creative writing as well as their self-confidence in writing.

A second study revealed that pupils' idea generation and creative thinking skills increased markedly when natural language generation (NLG) tools were used. The quantity and quality of ideas improved as pupils engaged with multiple AI-generated versions, modifying and developing their content. This broadened the creative process and enabled pupils to incorporate new ideas into their writing. The impact of multimodal AI tools was also significant. Images generated with DALL·E helped pupils visualize narratives more vividly and describe their ideas more precisely. Visual tools supported creative development by enabling learners to better understand story structures and fostering the use of metaphors and figurative thinking.

AI was also employed in role-play and dialogue activities. Pupils who worked with chatbots learned to express their ideas more freely and engage in communicative interaction. By constructing question-answer style dialogues and performing their roles with AI assistance, pupils enhanced both their oral creativity and their spoken language skills. AI contributed to increased learner confidence and provided corrective feedback during the process. Teacher-oriented AI tools also played an important role in AI-supported learning environments. Platforms such as Twee and LittleLit enabled teachers to create creative tasks quickly, making it easier to integrate creativity-focused activities into lessons. By using such AI tools, teachers were able to support pupils' cognitive and creative development more efficiently.

The research findings demonstrate that AI can be effectively used in primary school settings to enhance creativity. These tools support the development of pupils' writing, idea generation, and oral creative expression. Furthermore, the positive outcomes of AI integration depend on its pedagogically guided use. When used under teacher supervision and aligned with instructional goals, AI enables teachers to design creative tasks more rapidly and provide personalized support to learners.

Discussion

This study demonstrated the importance of using artificial intelligence as an effective tool for developing creative skills among primary school learners in English language classes. The findings indicate that ChatGPT and other multimodal AI tools contribute to improving students' writing skills, enhancing idea-generation abilities, and increasing confidence in oral creative tasks. While the results confirm the potential of AI for fostering creativity, they also show that its effectiveness depends largely on the teacher's methodological guidance.

Compared with previous research, this study highlights how AI influences creative writing skills specifically at the primary school level. For example, a 2025 study found that students who worked with ChatGPT showed significant improvement in their writing abilities, although this progress strongly depended on the teacher's ability to guide learners in applying their creative skills appropriately [7]. Our findings align with this conclusion: AI can enhance creativity, but this process is effective only when combined with pedagogical monitoring. Furthermore, an analysis of studies on multimodal AI tools shows that visual elements (such as images generated by DALL·E) help open new dimensions of creative thinking. This is consistent with findings from Wieland et al. (2022), which showed that AI-assisted brainstorming or dialogue-based tasks improve both the quantity and quality of ideas generated [11].

However, the use of AI also comes with limitations. A commonly discussed concern is students' overdependence on AI and the potential mechanization of creativity. Research by Sharma et al. (2025) and Smith (2003) warns that initial ideas offered by AI may narrow the creative process and restrict divergent thinking [13,14]. To address these challenges, teachers must guide learners not only to use AI but also to transform, critique, and creatively reinterpret AI-generated suggestions.

Conclusion

This study has provided a deeper understanding of how artificial intelligence can be used as a tool for fostering creativity among primary school learners. The key findings demonstrate that AI has a positive impact on students' creative writing skills and their ability to generate original ideas. The use of multimodal AI tools such as ChatGPT and DALL·E was shown to enhance learners' creative thinking, supporting the development of both their written and oral work. The research confirms that AI tools can be effective for primary school students; however, their successful integration requires thoughtful pedagogical guidance and teacher supervision. To fully unlock learners' creative potential, it is essential to strike a balance between guided and independent use of AI during creative tasks. Future studies should explore the use of AI in a wider range of creative activities and identify strategies to reduce students' overdependence on AI-generated content. The findings of this study hold significant value for educators and policymakers across all levels of the education system. Integrating AI into the learning process contributes not only to the development of language skills but also to the enhancement of broader creative thinking abilities. Thus, the meaningful incorporation of AI into educational practice can play an important role in supporting students' holistic development.

In my opinion, the growing presence of AI in education offers a unique opportunity to rethink traditional approaches to creativity. When used responsibly and pedagogically, AI can become not a replacement for human imagination, but a catalyst that empowers young learners to explore, create, and express their ideas with greater confidence and originality.

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Исследование в действии: Развитие навыков анализа и интерпретации учащихся через решение прикладных, практико-ориентированных задач методом математического моделирования

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Обучение математике учащихся старших классов, подготовка к СО выявили следующую проблему: учащиеся испытывают затруднения при решении прикладных, практико-ориентированных задач. Обучающиеся с высокой мотивацией, владеющие математическими методами, показывают низкий уровень функциональной грамотности, применяя аппарат математики к решению задач практического характера. Проблему обсудили с коллегами МО, психологами, учителями предметов естественного цикла. Выяснили: подобные затруднения не являются локальными, они возникают в других классах, на уроках смежных дисциплин. Анкетирование 86 учащихся 11-12 классов выявило, что 28,5% испытывают затруднения при решении практико-ориентированных задач; выполняя задания, в которых информация представлена графически, в виде таблиц, диаграмм, трудности испытывают 31%; при выполнении задач с параметрами - более 34% старшеклассников. Аналитический отчет ЦПИ (по итогам СО2024) подтвердил, что проблема существует у значительного количества обучающихся. По данным отчета задания третьего компонента, где основная часть задач на оценивание применения математических методов и обоснования, выполнены учащимися по сети НИШ, в среднем, на 49,5%. Для сравнения – задачи первого и второго компонентов выполнены на 67,14 и 60,94% соответственно. В задачах третьего компонента с практическими контекстами учащимся необходимо применять математические приёмы, извлекать информацию из диаграмм, изображений фигур, выполнять преобразования, интерпретировать результаты.[1] Вышеизложенная проблема, подтвержденная аналитическими данными, определила цель моего исследования практики: «Развитие навыков анализа и интерпретации учащихся 11 классов через решение прикладных, практико-ориентированных задач методом математического моделирования». Исследовательский вопрос: «Как решение прикладных и практико-ориентированных задач методом математического моделирования влияет на развитие навыков анализа и интерпретации учащихся?»

Чем обоснован выбор метода математического моделирования (ММ)? Во-первых: метод ММ – дидактически обоснованный, действенный инструмент развития навыков анализа,

абстрагирования, умений выдвигать гипотезы, обосновывать выбор приемов решения прикладных задач, сопоставлять свойства модели со свойствами реального объекта, интерпретировать результаты, полученные при исследовании модели. Математические модели прикладных задач выступают не только как объект обучения, но как результативное средство обучения. Во-вторых: метод ММ показывает практическую значимость математики как науки, осуществляет межпредметную интеграцию. С помощью ММ решаются прикладные задачи естественных и социальных наук, что формирует единую систему научного мировоззрения обучающихся. В ряде исследований установлена связь между воздействием ММ и образовательным воздействием на учащихся. Согласно исследованиям, результаты Blum&Ferri(2009)[2], студенты, которые в процессе обучения математике и естественным наукам изучали и применяли метод ММ, чувствовали себя уверенными, лучше ориентированными на решение практических проблем, понимали предмет глубже, чем при традиционном подходе.

Для исследования был выбран урок «Решение прикладных задач, связанных с наибольшим/наименьшим значением функции» в 11 классе. Цель обучения: 11.5.1.16решать задачи, связанные с наибольшим/наименьшим значением функции на промежутке. Решение оптимизационных задач – потенциально сложная, практически значимая тема. Для достижения целей обучения здесь требуются математические знания, междисциплинарная интеграция, навыки высокого порядка: анализ данных, формализация, интерпретация решений, что соответствует теме исследования. Междисциплинарные связи установили в процессе вертикального планировании, что определило контент дидактического материала, направленного на развитие навыков высокого порядка. Физика (Движение.9.2.1.1объяснять физический смысл таких величин как перемещение, скорость, ускорение;9.2.1.4находить скорость по наклону графика зависимости пути от времени;9.2.1.5определять ускорение по наклону графика зависимости скорости от времени); экономика (темы: Методы оптимизации и модели в экономике. Оптимизационные задачи на минимум/максимум); химия темы: Скорость реакции). Ожидаемые результаты урока:

предметные: уметь составлять математические модели и решать прикладные оптимизационные задачи;

метапредметные: умение применять математический аппарат к решению практических проблем из области естественных наук;

личностные: развитие коммуникативных навыков, саморегуляции, лидерства.

В исследуемой группе обучается 11 человек. При планировании учитывала психолого-педагогическую характеристику класса, виды мотивации, мышления, типы восприятия информации и ведущей деятельности. По результатам тестов «Аналитические математические способности. Форма А"(АМС.А) и математических аналогий, обладающих высокой степенью достоверности и определяющих уровень развития способностей к решению задач, понятийного и пространственного мышления, условно поделила учеников на группы High, Middle, Low level (4, 5 и 2ученика). Выбор стратегий преподавания, форм работы обоснован тем, что преобладающие типы мышления обучающихся – символический и знаковый(64% и 36%), по типу восприятия информации - «визуалы», «аудиалы», «кинестетики»(5, 4 и 2учащихся). Для учащихся разных модальных типов выбирала преимущественные их восприятию виды деятельности и ресурсы: видеоролик, презентация к уроку, постеры - для визуализации обучения; беседа и дискуссия (оптимальные для аудиалов); составление задач, оформление постеров(функциональные для кинестетиков). Чтобы активизировать познавательные процессы всех учащихся, определить ожидаемые результаты урока, создать условия для диалога, запланировала фронтальную работу на этапе актуализации знаний. Организацию парной работы выбрала как оптимальную для

закрепления ЗУНов. Взаимобучение, диалог, поддержка в парах, потенциал Highlevel учащихся, анализ условий, совместный поиск решений, обсуждение результатов способствуют достижению целей урока и развитию навыков анализа, интерпретации, коммуникации, саморегуляции. Групповая форма работы планировалась как основная. Предполагала, что в группах определяют ожидаемые результаты работы, распределяют функции между учащимися, будут обсуждать контексты прикладных задач, составлять модели, решать оптимизационные задачи профильных предметных областей, сопоставлять условия, формулировать выводы, оценивать результаты, оформлять постеры, презентовать работу групп. Данные компетентностные виды деятельности, элементы диалогового обучения будут непосредственно направлены на развитие навыков анализа и интерпретации. При разработке ресурсов и заданий опиралась на ведущий тип деятельности, уровни сформированности навыков. К заданиям составила критерии оценивания и дескрипторы. Составила вопросы к содержанию урока, способствующие развитию критического мышления. Межпредметную интеграцию рассчитывала осуществлять через решение прикладных задач, таких как: Материальная точка движется по закону $S(t) = -t^3 + 6t^2 + 37t + 30$. Найдите наибольшую скорость точки и момент времени, когда скорость максимальна. Дифференциацию запланировала по уровню сложности, объему, контексту задач, по типу ведущей деятельности, по характеру предоставляемой помощи и степени самостоятельности. Для поддержки учащихся составила опорные таблицы физических, химических формул. В течение всего урока учащиеся будут самооценивать свою учебную деятельность. Исследования показывают Rolheiser, C., & Ross, J. A. (2001) [2], что объективное самооценивание на основе «прозрачных» критериев – наиболее продуктивный вид оценивания, который помогает учащемуся проанализировать, критически осмыслить свою деятельность, выявить ошибки, определить их причины, найти пути устранения. В совокупности процедур планируемый процесс самооценивания способствует достижению целей урока, развивает навыки высокого порядка. Взаимооценивание предусматривала на этапах закрепления ЗУНов во время парной и групповой работы. Выбор обоснован тем, что деятельность в процессе взаимооценивания позволяет глубже понять алгоритмы решения, помогает идентификации и выявлению причин собственных ошибок, предоставляет учащимся возможность объяснять, анализировать, делать выводы, обосновывать оценку, что развивает навыки анализа, интерпретации. Для каждого этапа разработала инструменты оценивания, листы самооценивания, взаимооценивания, наблюдения урока. В листе наблюдения и оценивания учителем продумала оценивание каждого вида деятельности учащегося. Для получения объективных и полных результатов структурировала оценку для парной и групповой работы. Оценивала планируемые стратегии и разработанные ресурсы с точки зрения целесообразности и эффективности к достижению целей и ожидаемых результатов урока и исследования собственной практики.

Чтобы устранить субъективность при самоанализе, повысить валидность выводов о степени эффективности выбранных стратегий обучения, форм работы, инструментов оценивания, на уроке присутствовали педагоги фокус-группы. Коллеги заполняли листы наблюдения, комментировали положительные и требующие корректировки аспекты урока.

Для активизации познавательной деятельности урок начала с видеоролика «Вся жизнь - задачи оптимизации», затем озвучила и продемонстрировала тему, обучающие цели. Учащихся попросила самостоятельно определить ожидаемые результаты урока и критерии оценивания. Старшеклассники имеют сформированные навыки такой деятельности, поэтому четко определили ожидаемые результаты и критерии: определяет алгоритм решения оптимизационных задач; анализирует условие, составляет математическую модель; интерпретирует результаты в контексте условия задачи. Данные критерии

направлены на оценивание навыков анализа, интерпретации. На стадии вызова задавала вопросы практического, интерпретационного, оценочного характера, предлагала привести примеры, выдвинуть гипотезы: Какие оптимизационные проблемы возникают перед физиками, химиками, биологами? Приведите примеры практических оптимизационных задач, возникающих при изучении естественных наук, в жизни. Какие средства используются для решения задач оптимизации? Модели вопросов «высокого уровня» связали тему урока с ранее изученными понятиями, установили междисциплинарные связи, создали условия для диалога, обсуждения идей, что способствовало развитию навыков анализа и интерпретации. Ребята активно включились в диалог, приводя примеры оптимизационных задач. Учащиеся, из группы Lowlevel, также предложили свои задачи о расчете оптимального маршрута поездки и вычислении наибольшей высоты подъема тела, подброшенного вертикально вверх. При обсуждении обращала внимание на использование предметной терминологии. Внимательно слушала ответы, делала пометки в листе оценивания, что помогло мне, в совокупности с другими видами формирующего оценивания, реализованными на уроке, определить уровень достижения целей каждого учащегося. Учащиеся делали отметки в листе самооценивания в колонках: привел(а) практические примеры оптимизационных задач/затрудняюсь привести примеры оптимизационных задач.

Для закрепления ЗУНов через организацию парной работы составила задачи из курса физики, химии, экономики. Дополнительно, при условии выполнения стандартных заданий, предоставляла выполнить задачу повышенного уровня сложности с параметром. Дифференциация осуществлялась по уровню сложности, контексту заданий - пары получили задачи, соответствующие их профильной подготовке, уровню сформированности навыков, по степени предоставляемой поддержки. В качестве скаффолдинга учащимся предоставила формулы, необходимые для решения задач из предметных областей, что повысило продуктивность и скорость решения. Для поддержки неуверенных детей были сформированы пары High - Low и High - Middlelevel учащих. Потенциал одаренного учащегося в паре High – Middle использовался для поддержки и развития второго ученика, в паре High – Lowlevel для коррекции знаний «слабого». Оценивая результаты, отметила, три пары High – Middlelevel смогли верно решить задачи с параметром, что свидетельствует о целесообразности такого формирования пар. Анализ урока показал, что диалог в парах носил поисково- и кумулятивно-исследовательский характер, что способствовало активному взаимообучению, развитию навыков анализа, интерпретации при выборе метода решения задачи и оценке полученных результатов. Однако в паре High – Lowlevel «слабый» учащийся не смог выполнить решение задачи. Поняла, что при планировании нужно было продумать дополнительные виды поддержки для учащихся группы риска. Тип формативного оценивания – взаимооценивание в парах на основе предоставленных учителем схем оценивания и разработанных учащимися критериев. Наблюдения и комментарии учащихся показали, что 4 пары полностью выполнили задания, все пары смогли объективно и обоснованно провести взаимооценивание работы.

Основной частью урока стала групповая работа. Деление было проведено через стратегию «Градиент». Чтобы определить группу, ученик, взяв карточку с заданием, должен вычислить значение производной функции в точке. Выбранный прием считаю рациональным. Он решил несколько дидактических задач. Учащиеся применяли правила дифференцирования сложной функции, что способствовало закреплению навыков. Стратегия «Градиент» стала одним из видов формирующего оценивания. В процессе деления ученик не мог определить группу, так как неверно вычислил производную. Отметила, что учащемуся необходимо занятие по коррекции знаний. Перемещение ребят по классу выполнило функцию динамической разминки.

Учащиеся в группе получили две прикладные задачи; следовало совместно выполнить, записать решение. Затем самостоятельно или при поддержке группы составить прикладные задачи, связанные с наибольшим/наименьшим значением функции из профильных предметных областей, оформить результаты работы. Учащиеся обсуждали и выбирали контекстные ситуации из предметных областей, составляли условия, математические модели, выполняли решение задач, интерпретировали результаты, комментировали и записывали ответы. Принцип дифференциации – углубление: *все* смогли решить прикладные задачи; *некоторые* (7 из 11 учащихся) смогли составить оптимизационные задачи. Составление контекста, обсуждение, решение оптимизационных задач развивали навыки анализа и интерпретации. Модель обучения в группе способствовала развитию коммуникативных навыков. Стратегия оценивания – самооценивание. В листе самооценивания учащиеся в баллах, по шкале от 0-5, анализировали и оценивали свой вклад в работу группы, степень самостоятельности в составлении контекста и решении задач. Наиболее информативными считаю ответы на качественные вопросы: какой из этапов работы на уроке помог тебе лучше понять алгоритмы решения оптимизационных задач? Решение готовых задач стало «подмошкой» для дальнейшего составления задач прикладного характера. Учащиеся хорошо справились с заданием. Поддержка, выдвижение и обсуждение идей в группе помогли определить подходящий контекст. Работа в группе максимально способствовала решению учебных и воспитательных задач урока, развитию заявленных в исследовании навыков. В листах самооценивания 9 из 11 учащихся поставили себе высокие или максимальные баллы, отметили эффективность групповой работы, положительно оценили возможность получить поддержку группы.

Результаты работы группы оценивали учащиеся других групп через стратегию «Критический друг», на основе представленных учителем критериев и схемы. Рекомендовала каждому учащемуся продумать, записать и озвучить конструктивное предложение с целью улучшения работы друг друга. Учащиеся уточняли условия, обсуждали решения, находили общие пункты и различия, делали выводы о результативности работы, заполняли листы взаимооценивания. Наблюдала, что все были вовлечены в процесс диалога, вносили предложения по возможному способу улучшения решений, поясняя и обосновывая их необходимость. Считаю, что такая форма представления и оценивания результатов работы являлась оптимальной, были созданы условия для совместной деятельности, обучения в диалоге, развития навыков анализа, интерпретации. Ключевой принцип дифференциации– углубление: *все* смогли дать несложные рекомендации; *некоторые* (5 из 11 учащихся) смогли дать конструктивные рекомендации по улучшению решения задач. Учащиеся вносили предложения следующего характера: для упрощения вычисления производной рациональнее представить оптимизируемую функции в виде...для корректного решения необходимо внести ограничения для переменной..., что не только доказывает достижение целей урока, но и достаточно высокий уровень развития навыков анализа и интерпретации.

Подводя итоги, учащиеся заполняли рефлексивные листы, закончив фразы или ответив на вопросы: на уроке я научился... Чтобы лучше решать практические задачи, мне необходимо.... В каких сферах могут использоваться знания, приобретенные на уроке? Значимым является неформальный подход к организации рефлексии, контексту вопросов. Ответы учащихся учитываю при планировании последующих уроков, определяя виды работ и заданий для коррекции «западающих» навыков, при организации индивидуальной работы.

На уроке применяла различные стратегии и приемы оценивания. На этапе целеполагания учащиеся, опираясь на обучающие цели, определяли критерии оценивания, ожидаемые результаты урока. Данный вид работы очень результативен, так как самостоятельное

определение критериев делает процесс оценивания понятным для учащихся, повышает уровень саморегуляции и ответственности за достижение целей урока. На стадии вызова учащиеся заполняли листы самооценивания, я наблюдала за ответами, делала пометки в листе оценивания учителем. Выбор таких видов оценивания определялся пониманием того, что не все учащиеся, исходя из временных рамок и количества вопросов, успеют ответить, поэтому их объективная самооценка поможет определить на каком уровне достижения целей они находятся. Комментируя процесс самооценивания, учащиеся говорили: для достижения целей урока мне нужно повторить правила дифференцирования..., чтобы повысить свои результаты я должен научиться составлять модели..., что говорит о самоанализе деятельности. Работая в парах, учащиеся проводили взаимооценивание на основе критериев и предоставленных схем оценивания. Дескрипторы к заданиям в схеме оценивания помогли учащимся понять причины ошибок, исправить их, что способствовало достижению предметных целей урока, подготовило к групповой работе и ее оцениванию. Оценивая работу в парах, учитывала не только конечный результат, но и умение обосновывать решения, делать выводы при интерпретации результатов, что помогло мне сформировать более обоснованный вывод об уровне достижения целей и степени сформированности навыков анализа и интерпретации учащихся. Также отмечала уровень владения предметной терминологией, так как именно терминология отвечает за ясность понимания научной информации и коммуникативные навыки учащегося, как средства обмена информацией. Для групповой работы были предоставлены критерии, направленные на оценивание навыков анализ, интерпретация: составляет описательные и математические модели процессов...; устанавливает функциональные зависимости между величинами; исследует математические модели; интерпретирует результаты; вносит рациональные предложения по и т.д. Однако механизм оценивания работы групп продумала не полностью, поэтому трудно было оценить степень участия в совместной работе отдельных учащихся. В дальнейшем буду четко определять роль и функции каждого ученика в группе, что поможет объективно его оценить. Со стороны учащихся взаимооценивание групповой работы не вызвало затруднений. Они комментировали и обосновывали оценки, отмечая положительные и отрицательные моменты, давали рекомендации по улучшению работы. Анализируя урок, поняла, при взаимооценивании групповой работы, несмотря на дополнительные затраты времени, полезнее было не предоставлять готовых критериев. Составление и обсуждение критериев оценивания учащимися позволило бы самостоятельно определить уровни достижения целей, пути исправления ошибок. В течение урока подробно комментировала работу учащихся, предоставляя рекомендации по улучшению решений. Своевременная, информативная обратная связь корректировала и направляла деятельность учащихся, способствовала достижению целей.

Анализируя ключевые моменты урока с коллегами, пришли к выводу об эффективности и целесообразности выбранных стратегий преподавания, форм работы, ресурсов, инструментов оценивания. Комфортная психологическая атмосфера на уроке, стратегии скаффолдинга, элементы диалогового обучения, дифференциация и межпредметная интеграция способствовали развитию навыков высокого порядка. Коллеги отметили, что оптимальными были планирование и реализация этапов совместной работы учащихся и разработка заданий для групп. В процессе совместной деятельности учащиеся выработали алгоритмы решения оптимизационных задач, которые будут применять при выполнении заданий СО. Определение контекста оптимизационных задач для естественных наук, решение, интерпретация результатов, установление сходства и различий, оценивание, внесение предложений по улучшению - компетентностные задания, направленные на достижение целей урока, развивающие навыки анализа, интерпретации, формирующие умения применять научные методы в условиях решения практических проблем. Выбор

процедур и инструментов оценивания создал условия для развития навыков самоанализа учебной деятельности учащихся, способствовал достижению предметных и развивающих целей и ожидаемых результатов урока. Подводя итоги урока, учащиеся давали комментарии: Работая в паре мы составили и применили алгоритмы решения оптимизационных задач. В своей группе я предложил задачу о максимальной скорости реакции...Обсуждая возможности улучшения работы, я предложил перед дифференцированием упростить функцию. Такие комментарии свидетельствуют о достижении учащимися предметных и метапредметных целей урока, о довольно высоком развитии навыков анализа и интерпретации. Результаты оценивания и рефлексивные листы подтверждают - учащиеся достигли предметных и развивающих целей урока. Анкетирование, интервью учащихся после серии последовательных уроков показало положительную динамику, так уже 19,8% (первоначально 28,5%) испытывают затруднения при решении практико-ориентированных задач; при выполнении заданий, в которых информация представлена графически трудности испытывают 26% (первоначально 31%) учащихся. Совокупность результатов, полученных при исследовании собственной практики, позволяет сделать вывод о положительном влиянии регулярного решения прикладных и практико-ориентированных задач методом ММ на развитие навыков анализа и интерпретации учащихся.

Комплексный анализ урока выявил и слабые стороны: недостаточно был задействован потенциал одаренных детей, не всегда результативной была поддержка учащихся Lowlevel, на уроке мало применялись ИКТ. При планировании уроков в дальнейшем буду эффективнее применять возможности ИКТ, в частности и для процедур оценивания, тщательнее продумывать приемы поддержки слабых учащихся. Продолжу работу по исследованию и совершенствованию собственной педагогической практики, повышению профессиональных компетенций. Проведу семинар для учителей математики, физики, химии по обобщению опыта и результатов данного исследования и определению стратегии дальнейшей работы по расширению области исследования. Совместно с коллегами будем продумывать механизмы улучшения процедур и инструментов оценивания групповой работы.

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What reforms are needed to strengthen school–industry partnerships in Azerbaijan’s general education system to enhance students’ practical skills, career readiness, and future employability?

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Abstract

This study examines the reforms required to strengthen school–industry partnerships in Azerbaijan’s general education system. Using a mixed-methods approach, the research analyses current practices, identifies structural and institutional barriers, and explores stakeholder perceptions to develop a contextually grounded framework for sustainable collaboration. The findings reveal fragmented partnership activity, constrained by curricular rigidity, governance gaps, teacher readiness challenges, and significant regional disparities. Policy recommendations include establishing a national partnership framework, enhancing industry incentives, integrating applied learning into the curriculum, strengthening teacher development, and creating digital and regional intermediary structures. The study contributes to theoretical debates on partnership governance in transition economies and offers a forward-looking roadmap for aligning general education with the demands of modern labour markets.

Introduction

Across many education systems, there is a growing expectation that schools should play a more proactive role in preparing young people for a labour market shaped by technological acceleration, shifting skill demands, and increasingly fluid career trajectories. In an ideal scenario, general education would equip students not only with foundational knowledge but also with a meaningful understanding of how learning connects to real workplaces, practical competencies, and emerging career pathways. Well-designed school–industry partnerships offer precisely this bridge by creating structured opportunities for students to explore work environments, engage with professionals, and apply academic concepts in authentic contexts (Musset, 2019; Mann et al., 2020). Yet the promise of such partnerships often exceeds their institutional reality, particularly in systems where schooling has long been framed as an academic preparation ground rather than a conduit to employability or economic participation.

Azerbaijan exemplifies this challenge. Although the country’s policy agenda increasingly emphasises digital transformation and the development of a knowledge-driven economy, the general education system remains only loosely connected to industry. One might reasonably expect closer ties between schools and major sectors such as energy, ICT, engineering, and creative industries, given their strategic importance. However, current partnerships tend to be episodic being a short-term STEM club supported by a technology company, a single-day visit to an industrial plant, or a career fair organised by an NGO. These activities, while valuable, lack cohesion and sustainability and are rarely embedded in the curriculum or supported by formal

governance mechanisms (Isayev & Aliyev, 2022). A recent example illustrates this point well: a pilot coding initiative introduced in several Baku schools in 2022 generated excitement but was discontinued after one academic year due to limited staffing, absence of regulatory guidance, and unclear expectations for industry participation. Such cases underscore how promising initiatives often fail to move beyond isolated projects in the absence of system-level architecture.

The consequences of this fragmentation are both immediate and far-reaching. Students complete eleven years of schooling with minimal exposure to workplace environments and therefore graduate uncertain about career options, unfamiliar with professional expectations, and lacking practical competencies demanded by employers (European Training Foundation, 2020). These patterns hinder the country's human capital development goals and place increasing pressure on higher education and vocational institutions to remediate gaps that could have been addressed earlier. Moreover, regional disparities exacerbate inequity, as urban schools often have greater access to industries compared to rural and economically disadvantaged regions. As the OECD (2021) and World Bank (2022) highlight, such systemic weaknesses contribute to skill mismatches and restrict upward mobility, reinforcing socioeconomic divides.

International efforts to strengthen school–industry collaboration offer valuable reference points but also highlight the importance of contextual fit. Germany and Austria's dual-system models integrate schooling with structured apprenticeships, while Singapore embeds applied learning pathways within its curriculum. Finland, meanwhile, emphasises project-based and experiential pedagogy to create authentic learning environments (Kuczera & Field, 2018; Archer & Moote, 2016). These systems share characteristics such as strong governance, institutional capacity, and cultural acceptance of work-based learning that cannot simply be transplanted into Azerbaijan's context. Local research tends to focus on digitalisation, curriculum reform, or teacher development rather than on systematic models for school–industry engagement in general education (Mahmudov, 2021). As a result, existing partnerships are fragmented, short-lived, and unsupported by policy, incentives, or curricular alignment.

These observations point to the central knowledge gap addressed in this study. While global scholarship demonstrates the benefits of employer engagement, very little research examines what specific reforms are necessary for such partnerships to function sustainably within Azerbaijan's general education system. The missing conversation is structural and systemic: What governance mechanisms, policy interventions, curricular adaptations, and capacity-building measures would enable long-term, equitable, and meaningful collaboration between schools and industry? Existing literature does not provide an integrated reform framework suited to Azerbaijan's institutional and socioeconomic context. This study seeks to fill that gap.

The theoretical grounding for this inquiry draws on human capital theory, which views education as an investment in individuals' productive capacities and highlights the economic rationale for early skill development (Becker, 1993). Partnership governance frameworks complement this lens by emphasising coordinated responsibilities, shared incentives, and institutional arrangements that support collaborative relationships (Bryson et al., 2015). Together, these perspectives illuminate why partnership initiatives often fail in contexts lacking regulatory clarity, institutional capacity, or alignment of interests—and why structural reform is necessary.

This study pursues four interconnected objectives. First, it analyses the current extent, nature, and limitations of school–industry collaboration in Azerbaijan's general education system, drawing on insights from educators, policymakers, and industry representatives (Isayev & Aliyev, 2022). Second, it identifies the policy reforms including regulatory mechanisms, incentive structures, and governance arrangements that could support more stable and sustainable partnerships (Bryson et al., 2015). Third, it investigates the curricular and pedagogical adjustments needed to embed authentic learning tasks, project-based approaches, and early career exploration in everyday teaching practice (Musset, 2019). Finally, it develops a contextually grounded framework outlining

how schools and industry can collaborate effectively within Azerbaijan's evolving socioeconomic landscape.

These objectives matter because employers in Azerbaijan, as in many countries, increasingly expect graduates to possess not only academic proficiency but also adaptability, communication skills, digital literacy, and familiarity with workplace norms (Mann et al., 2020). A reimagined model of school–industry collaboration provides one pathway toward aligning general education with these evolving expectations and strengthening the country's competitiveness.

The paper is organised as follows. It begins with a critical review of international and regional literature, identifying where Azerbaijan converges with and diverges from global patterns of partnership development. The methodology section outlines the mixed-methods design, combining quantitative surveys with qualitative interviews to capture both breadth and depth. The results section maps the existing landscape of collaboration and articulates how stakeholders envision reform. The discussion interprets these findings through the lenses of human capital and partnership governance theories, and the conclusion presents an integrated reform model tailored to Azerbaijan's general education system.

Literature Review

Strengthening school–industry partnerships has become a central theme in contemporary education reform, particularly as governments seek to align schooling with the dynamic skill demands of modern economies. The rationale underlying this focus is straightforward: when schools operate in isolation from the labour market, students graduate with limited understanding of workplace expectations and few opportunities to transform theoretical knowledge into applied competencies. This risk is especially pronounced in systems where traditional academic instruction dominates and where mechanisms for sustained engagement with industry are underdeveloped. Azerbaijan's general education system reflects this broader global challenge. Although national policy increasingly prioritises innovation and human capital development, the institutional conditions needed to support systematic school–industry collaboration remain weak. To identify relevant reforms, it is essential to critically examine the international evidence base, assess how school–industry partnerships are conceptualised across contexts, and determine which elements of existing models may be transferable to Azerbaijan.

A substantial body of international literature converges on the idea that effective school–industry collaboration depends on systemic reforms related to governance, regulation, curriculum design, and incentive structures rather than on individual or short-term initiatives (Kuczera & Field, 2018; Musset, 2019). These insights are rooted in human capital theory, which contends that deliberate investments in students' exposure to work environments enhance productivity and future employability (Becker, 1993). Germany's dual education system exemplifies an institutionalised model where such principles have been operationalised effectively. Through a comparative analysis of Switzerland and Germany, Kuczera and Field (2018) demonstrate that robust employer participation, national qualification systems, and clearly distributed responsibilities among stakeholders are crucial to success. Their mixed-methods approach strengthens the credibility of their findings. However, their focus remains firmly on vocational education. Consequently, questions arise about the transferability of such models to general education systems, particularly those like Azerbaijan's that do not possess a longstanding culture of employer–school integration. Research focusing on employer engagement within general education offers different insights. Mann et al. (2020), drawing on longitudinal evidence from OECD countries, argue that even low-intensity interactions such as career talks or brief workplace visits can positively influence students' career confidence, labour-market understanding, and eventual employment outcomes. Their study is methodologically rigorous, incorporating large datasets that support causal claims. Yet the contexts where these interactions thrive are characterised by established employer–

school networks and strong labour-market information systems, conditions not yet present in Azerbaijan. As a result, while the findings underscore the benefits of employer engagement, they offer limited guidance on designing systemic reforms in environments where structural incentives for industry participation are weaker and regulatory frameworks are less developed.

Other studies, such as that by Archer and Moote (2016), foreground the psychological and motivational dimensions of industry engagement. Their longitudinal qualitative research illustrates how early exposure to scientific workplaces can significantly influence students' interest in STEM careers. This contribution is important for understanding why partnerships matter, yet it offers little insight into the governance, policy, or curricular mechanisms required to institutionalise such practices. The limitation of this research lies not in its methodological robustness but in its narrow focus on identity formation rather than systemic reform.

For transition economies and emerging education systems, analyses by international development organisations provide more contextually relevant insights. The European Training Foundation (2020) identifies weak employer engagement, limited coordination mechanisms, and fragmented regulations as pervasive challenges in Eastern Partnership countries. Similarly, the World Bank (2022) highlights that Azerbaijan faces structural skill mismatches, insufficient career guidance, and limited exposure to practical learning opportunities. These studies resonate strongly with the aims of the present research, especially in their emphasis on systemic constraints. Their limitation, however, lies in their broad scope: they offer national-level assessments without investigating the specific organisational and pedagogical conditions shaping general education schools' capacity to collaborate with industry.

Local scholarship, although limited, sheds additional light on structural barriers that must be considered when proposing reforms. Mahmudov's (2021) qualitative analysis of ICT integration in Azerbaijani schools highlights issues such as unequal digital access, insufficient teacher preparation, and inconsistent implementation of national reforms. While not focused directly on school–industry collaboration, the study exposes systemic challenges particularly in infrastructure and teacher readiness that could impede partnership efforts. The methodological strength of Mahmudov's work lies in its detailed observation and stakeholder interviews, yet the absence of explicit attention to industry engagement limits its relevance for partnership governance. Even so, the findings underscore the importance of addressing capacity gaps alongside policy reform.

Similarly, Isayev and Aliyev (2022) examine ongoing education reforms and digitalisation efforts in Azerbaijan, revealing persistent implementation bottlenecks despite ambitious policy objectives. Their work is grounded in analysis of policy documents and interviews with ministry officials, offering insight into why reforms often fail to materialise at the school level. Although the authors do not focus specifically on partnerships, their findings suggest that systemic reforms in governance, resource allocation, and school-level autonomy will be necessary prerequisites for any sustained school–industry collaboration.

Synthesising the international and local literature reveals several notable patterns. First, while global research emphasises coherent national frameworks and strong employer incentives, the Azerbaijani context is characterised by fragmented governance and weak institutional capacity. Second, most robust studies focus on vocational or secondary education systems, leaving general education under-examined. Third, although the motivational benefits of employer engagement are well documented, significantly less research addresses the systemic reforms required to scale such engagement in settings with limited economic diversity or uneven regional development. Finally, existing scholarship tends to conceptualise partnerships as interventions rather than as components of systemic redesign, leaving unanswered questions about how policy, curriculum, leadership structures, and industry incentives must be aligned for sustained impact.

These gaps directly shape the contribution of this study. While existing literature clarifies why school–industry partnerships matter and how they function in well-resourced systems, it does not

provide a reform-oriented framework for countries like Azerbaijan, where institutional histories, economic geographies, and governance structures differ markedly from those of Western Europe. This study addresses that gap by analysing the policy, institutional, and curricular reforms required to cultivate sustainable, equitable, and pedagogically meaningful partnerships in Azerbaijan's general education system.

In summary, the literature establishes a strong conceptual foundation for understanding the value of school–industry collaboration but provides only partial guidance for reform in the Azerbaijani context. By integrating insights from human capital theory and partnership governance frameworks, and by grounding the analysis in the realities of Azerbaijan's education system, the present research contributes to a more nuanced and context-sensitive understanding of how such partnerships can be reimagined as part of broader general education reform.

Research Method

This study adopted a mixed-methods design that integrated quantitative survey data with qualitative interview evidence to investigate the reforms needed to strengthen school–industry partnerships in Azerbaijan's general education system. A mixed-methods approach was chosen because the research problem is multidimensional, involving policy arrangements, institutional practices, and human perceptions that cannot be captured adequately through a single methodological lens. Quantitative data offered a broad mapping of partnership activity across schools, while qualitative insights illuminated the nuances of stakeholder experiences and the contextual factors that shape collaboration. The methodological pluralism adopted here reflects a growing consensus that complex educational challenges require approaches capable of addressing both systemic patterns and individual interpretations (Creswell & Plano Clark, 2018).

The research was carried out between March and September 2024 within Azerbaijan's general education system. This particular timeframe was chosen intentionally, as it captures activity across two critical periods: the spring semester, when schools typically engage in career-related events, and the beginning of the new academic year, when planning structures and administrative routines are set in motion. Azerbaijan's education system is characterised by centralised governance, ongoing digitalisation initiatives, and uneven levels of industry engagement across regions. These dynamics created a compelling environment for examining existing practices and the structural constraints that shape them, particularly given recent national strategies emphasising labour-market alignment and human capital development. The extended timeframe further allowed the study to observe whether seasonal cycles or administrative rhythms influenced schools' ability to cultivate or sustain partnerships.

The quantitative phase involved a structured survey administered to school leaders across 118 general education institutions selected using stratified sampling. The sampling strategy ensured representation across diverse socioeconomic contexts, linguistic settings, and regional characteristics. The survey instrument was developed to gather information on existing partnerships, the frequency and nature of industry involvement, access to resources, and perceived barriers to collaboration. Items drew on international employer-engagement frameworks (Mann et al., 2020) but were adapted to reflect local policy terminology and institutional conditions. Ninety-six valid responses were collected, providing adequate statistical power for descriptive and comparative analyses. Quantitative data were analysed using SPSS Version 29 to produce descriptive statistics, cross-tabulations, and comparisons across urban and rural settings. These findings served as the initial layer of evidence, revealing structural disparities, regional differences, and recurring constraints across the system.

The qualitative phase proceeded concurrently but relied on purposive sampling to access stakeholders with direct experience in partnership formation and implementation. Semi-structured interviews were conducted with 24 participants, including school principals, teachers

responsible for extracurricular and career-development activities, policymakers from the Ministry of Science and Education, and representatives from technology, energy, and service-sector companies. This stakeholder mix was intentional, as meaningful reform requires considering perspectives from both educational and industry actors. Interviews lasted between 45 and 75 minutes and were conducted in Azerbaijani or Russian depending on participant preference. All interviews were audio-recorded, transcribed, and translated into English for analysis. The interview guide explored perceptions of partnership value, barriers to collaboration, experiences with previous initiatives, and expectations for policy or curricular reform. The semi-structured format provided consistency while allowing participants the freedom to share nuanced reflections, frustrations, and aspirations many of which would be difficult to capture in a survey instrument. Qualitative data were analysed through thematic analysis following the approach outlined by Braun and Clarke (2019). This method was selected because it provides a systematic yet flexible structure for engaging with rich, context-dependent data. The coding process began with inductive open coding, producing a wide set of categories related to governance challenges, curricular rigidity, teacher readiness, organisational norms, and uneven resource distribution. These initial codes were then clustered into broader themes aligned with the objectives of the study. To strengthen credibility and reduce researcher bias, two independent coders analysed the transcripts and compared their coding decisions. Discrepancies were discussed and resolved through iterative refinement, enabling the development of themes grounded securely in participant accounts rather than in preconceived analytical frames.

Ethical considerations were integral throughout the research process. Institutional ethical approval was obtained prior to data collection. All participants were informed of the study's aims, their right to withdraw at any point, and the measures taken to ensure confidentiality. Written consent was obtained from interview participants, and survey responses were collected anonymously. All data were stored securely and accessed only by the research team. These safeguards were especially important given the hierarchical nature of the education system and the possibility that educators or policymakers might hesitate to discuss systemic challenges without assurances of confidentiality.

The mixed-methods design proved highly effective in meeting the study's objectives. The quantitative data revealed overarching patterns for example, the prevalence of occasional rather than sustained partnerships and the stark differences between urban and rural schools while the qualitative findings explained why such patterns persist. For instance, limited curricular autonomy and scarcity of industry actors in rural regions surfaced repeatedly as explanations for quantitative disparities. This integration of findings across methods allowed the study not only to identify the reforms needed to strengthen school–industry collaboration but also to assess their feasibility within current institutional conditions. Such depth would have been difficult to achieve through a single-method design.

Overall, the methodological approach provided a rigorous and contextually grounded foundation for analysing the systemic, institutional, and pedagogical reforms required for effective school–industry partnerships in Azerbaijan. By combining breadth and depth, the study generated nuanced insights into the realities of partnership formation and illuminated potential pathways for sustainable reform.

Discussion

The findings of this study indicate that although Azerbaijan's general education system shows growing interest in school–industry partnerships, current practices remain sporadic, weakly institutionalised, and highly uneven across regions. The system recognises the conceptual value of collaboration but lacks the policy structures, governance mechanisms, and curricular flexibility required to embed partnership activity meaningfully. This mirrors patterns observed in broader

international research on education–industry alignment, yet the Azerbaijani context also introduces distinctive features that challenge standard reform assumptions. Understanding these nuances is essential for determining the kinds of reforms that could transform fragmented initiatives into sustained, equitable, and pedagogically meaningful partnerships.

One of the most prominent findings concerns the limited institutionalisation of school–industry collaboration. Many schools reported partnerships that were short-lived or largely symbolic, such as career fairs or occasional site visits rather than integrated, curriculum-connected experiences. This echoes regional analyses, particularly those from the Eastern Partnership countries, where employer involvement remains dependent on individual enthusiasm or donor-funded projects rather than systemic supports (European Training Foundation, 2020). The deeper issue emerging from the present study is the weak integration of such activities into the national curriculum. Educators repeatedly described a rigid, standardised curriculum that affords little room for experiential or applied learning. Such rigidity has also been observed in other transitioning education systems where traditional academic hierarchies and examination pressures limit opportunities for innovation (Isayev & Aliyev, 2022). The findings here reinforce this view, demonstrating that curricular inflexibility not only restricts pedagogical creativity but also deters industry actors who prefer substantive forms of engagement rather than peripheral or ceremonial roles.

Patterns of partnership formation also varied sharply by region. Urban schools, particularly those in proximity to economic hubs, reported significantly more engagement with industries, while rural schools faced limited access to potential partners. This geographic disparity aligns with international research showing that labour-market density strongly influences employer engagement (Mann et al., 2020). However, the Azerbaijani case magnifies this divide because many rural regions lack diverse industries altogether. In contrast to countries such as Finland or Singapore, where national coordination mechanisms help equalise opportunities across schools regardless of location, Azerbaijan’s decentralised and informal partnership environment reinforces regional inequality. These findings suggest that without systemic policy interventions such as intermediary structures or regional brokerage agencies partnerships will remain uneven and shaped largely by external geography rather than educational need.

Stakeholder perceptions of partnership value provide another layer of insight. Both educators and industry representatives articulated broad support for collaboration, citing benefits such as increased student motivation, enhanced soft skills, and early exposure to workplace cultures. These perceptions align with international evidence linking employer engagement to improved student outcomes and smoother transitions from school to work (Musset, 2019; Archer & Moote, 2016). Yet a closer examination reveals meaningful differences in stakeholder motivations. School leaders tended to emphasise pedagogical enrichment, whereas industry representatives framed their involvement in terms of corporate social responsibility, reputation-building, or long-term recruitment pipelines. Such mismatched expectations are consistent with partnership-governance scholarship warning that ambiguous motivations and weak accountability structures undermine sustainability (Bryson et al., 2015). The present study extends this argument by showing how, within weak regulatory environments, divergent motivations can lead to inconsistent and short-lived collaboration even when goodwill exists.

A further challenge lies in the absence of clear governance structures. Many participants expressed uncertainty regarding who should initiate partnerships, what responsibilities each party should assume, and how collaborations should be evaluated. This stands in contrast to institutionalised vocational systems such as Switzerland or Germany, where clear legal frameworks outline shared responsibilities between schools, employers, and government agencies (Kuczera & Field, 2018). High-income systems also tend to rely on intermediary organisations such as non-profits, chambers of commerce, or municipal agencies that facilitate

school–industry coordination (Mann et al., 2020). Azerbaijan lacks these mechanisms, leaving individual schools and companies to negotiate partnerships independently. From a theoretical perspective, this finding reinforces the human capital argument that investment in skills thrives when institutions reduce uncertainty and risk for participating stakeholders (Becker, 1993). Without governance clarity, collaboration remains ad hoc and highly dependent on the personal networks of school leaders rather than supported through formal systems.

Teacher readiness emerged as another significant barrier. Many teachers reported limited training in integrating industry-linked activities into their instruction and expressed discomfort deviating from the mandated curriculum. This echoes broader research in transition economies where teacher professional development often lags behind policy ambitions (Mahmudov, 2021). What distinguishes the present findings is the recognition that teacher readiness is constrained not only by pedagogy but also by institutional culture. Teachers operate within environments shaped by high-stakes assessments, rigid pacing guides, and administrative expectations that privilege consistency over experimentation. Partnerships require teachers to adopt new pedagogical roles such as coordinators, facilitators, boundary-spanners and without institutional support, these role extensions become burdensome rather than empowering.

Some findings challenge common assumptions in the international literature. Many partnership models presume that industries are naturally motivated to engage with schools if provided with clear frameworks and incentives. Yet several Azerbaijani industry representatives expressed hesitation due to resource constraints, concerns about bureaucratic procedures, or limited familiarity with educational systems. This contradicts models derived from organically collaborative economies and suggests that partnership-building in Azerbaijan may require industry socialisation, capacity-building, and trust-building processes that precede policy implementation. These insights highlight the importance of context-sensitive theories of partnership governance that account for institutional histories and economic cultures rather than assuming universal industry readiness.

The limitations of the study should be acknowledged. Although the schools sampled were diverse, they do not capture the full heterogeneity of the national landscape, and schools with proactive leadership may be overrepresented. The qualitative sample, while rich, included a limited number of industry representatives, which constrains the generalisability of conclusions about employer perspectives. The cross-sectional design provides a snapshot rather than a dynamic account of how partnerships evolve over time. These constraints may have encouraged findings that emphasise immediate challenges over emerging innovations.

Nevertheless, the study offers important implications for future research. Longitudinal studies could track partnership development across different reform cycles or administrative periods. More sector-specific research could explore industry participation beyond dominant fields such as technology or energy, particularly in rural and agricultural regions. Comparative research with countries undergoing similar post-Soviet educational reforms may illuminate the conditions under which partnership models transfer successfully. Future studies might also investigate intermediary or brokerage structures and examine their feasibility within the Azerbaijani governance context.

Overall, the findings highlight that sustainable school–industry collaboration requires far more than isolated activities or enthusiastic individuals. It demands systemic reform, coherent governance frameworks, strengthened teacher preparation, and equitable resource distribution. By situating these findings within the broader literature and theoretical frameworks, the study contributes to a more nuanced understanding of how industry engagement can transition from a peripheral activity to an integral component of general education in Azerbaijan.

Policy Recommendations

The findings of this study point to the need for comprehensive, system-level reforms that strengthen the institutional foundations of school–industry collaboration in Azerbaijan’s general education system. While enthusiasm for partnership activity exists, sustainable implementation requires coherent policy direction, curricular flexibility, enhanced teacher capacity, and targeted support for schools in regions with limited economic activity. The following recommendations are grounded in the empirical evidence generated by this research and informed by international models adapted to Azerbaijan’s unique structural and socio-economic context.

1. Establish a National Framework for School–Industry Partnerships

A formal policy framework is essential for moving partnerships beyond isolated initiatives. Such a framework should clearly define roles and responsibilities for schools, industries, local authorities, and the Ministry of Science and Education. It should specify acceptable models of engagement, outline minimum expectations for frequency and quality of activities, and include mechanisms for accountability and reporting. Establishing this framework would reduce the uncertainty currently faced by both schools and industry partners and create the institutional stability necessary for long-term collaboration.

2. Introduce Incentives to Encourage Industry Participation

Given the limited employer motivation identified in the study, targeted incentives are needed to stimulate industry engagement. Policymakers could introduce tax benefits, public recognition schemes, or corporate social responsibility alignment mechanisms for firms that actively participate in educational initiatives. Sector-specific incentives may be especially effective in industries with strong national importance, such as ICT, energy, and agriculture. Ensuring that incentives are simple, transparent, and accessible to both large companies and small or medium enterprises will help broaden participation.

3. Develop Regional Intermediary Structures to Reduce Inequities

To address the significant disparities between urban and rural schools, the government should establish regional intermediary bodies responsible for coordinating partnerships. These structures could identify potential industry partners, manage logistics, and support joint activities. In regions with limited industrial presence, these bodies could facilitate virtual collaborations, national-level partnerships, or shared arrangements among clusters of schools. Such intermediaries are common in high-performing systems and would help ensure that partnership opportunities do not depend solely on a school’s geographic location.

4. Integrate Applied Learning Pathways into the General Education Curriculum

Curricular rigidity emerged as one of the strongest barriers to meaningful partnership integration. National curriculum reform should therefore create space for project-based learning, applied tasks, and workplace-linked activities. This could include flexible curriculum modules, competency-based assessment frameworks, and cross-disciplinary projects aligned with industry themes. Aligning curriculum expectations with partnership activities would ensure that industry engagement complements, rather than competes with, academic requirements.

5. Strengthen Teacher Professional Development for Industry-Linked Pedagogy

Teachers’ readiness to engage with partnership activities is critical for ensuring that collaboration enriches learning. Professional development programmes should therefore equip teachers with skills in experiential learning, project design, and stakeholder engagement. Short-term placement schemes allowing teachers to spend time in industry environments could also enhance their ability to integrate real-world examples into lessons. These initiatives would empower teachers to act as facilitators of applied learning rather than passive recipients of external activities.

6. Invest in Digital Platforms to Expand Access and Innovate Collaboration

A national digital partnership platform could help overcome regional disparities by enabling virtual workplace tours, remote mentoring, online employer talks, and shared industry-led projects. Such

platforms would ensure that students in rural or economically disadvantaged regions have equitable access to industry exposure. Digital infrastructure also allows partnerships to scale more effectively and adapt to future disruptions, such as public health crises or economic shocks.

7. Pilot Sector-Focused Partnership Models Before Scaling Nationally

Rather than applying reforms uniformly, Azerbaijan could pilot partnership models in priority sectors—ICT, energy, agriculture, and creative industries—to assess feasibility and refine governance structures. Pilot programmes would provide evidence on what works, reveal unintended consequences, and inform gradual scaling. This approach reduces policy risk and strengthens the alignment between educational goals and national economic priorities.

8. Introduce Monitoring and Evaluation Systems to Ensure Quality and Equity

To prevent partnerships from becoming symbolic, the Ministry should implement a national monitoring system tracking the quality, frequency, and impact of partnership activities. Indicators should include student learning outcomes, employer satisfaction, and regional equity. Regular reporting would support transparency, inform policy adjustments, and provide incentives for schools and industries to sustain meaningful engagement.

Conclusion

This study set out to identify the reforms required to strengthen school–industry partnerships in Azerbaijan’s general education system so that students develop the practical skills, career awareness, and employability demanded by contemporary labour markets. Using a mixed-methods design, the research mapped existing partnership practices, examined institutional and systemic constraints, analysed stakeholder perspectives, and developed a contextually grounded framework for sustainable collaboration. The findings reveal a system characterised by genuine interest in partnership activity but constrained by structural barriers, rigid curricular norms, uneven geographic opportunities, and weak governance arrangements. While schools and industries have taken steps toward collaboration, these efforts remain episodic and insufficiently embedded within the fabric of general education.

The results underscore several critical insights that directly inform the policy recommendations proposed in this study. First, schools cannot and should not be expected to initiate and sustain partnerships in the absence of national frameworks that define roles, responsibilities, and incentives. The absence of such structures has left schools dependent on personal networks and ad hoc arrangements, limiting the scalability and equity of partnership efforts. Second, curricular inflexibility continues to obstruct meaningful integration of industry-linked learning. Without curricular space for applied, project-based, or workplace-oriented activities, even well-intentioned partnerships struggle to translate into improved learning outcomes. Third, teacher readiness emerged as a decisive determinant of partnership success; teachers require support, training, and autonomy to incorporate industry engagement effectively. Finally, the pronounced regional disparities in partnership access highlight the need for intermediary bodies and digital infrastructures capable of connecting schools in less industrialised regions with national-level or virtual industry partners.

The study’s theoretical contribution lies in demonstrating that dominant models of school–industry collaboration often built on assumptions of strong institutional capacity and employer motivation must be reinterpreted for transition economies. Human capital theory illuminates why early exposure to workplace contexts is beneficial, but its potential is undermined when systemic support structures are absent. Similarly, partnership governance theory must be adapted to account for contexts where industry collaboration has not historically been embedded in educational culture. By articulating these contextual dependencies, the study contributes to a more nuanced understanding of partnership development in systems undergoing rapid economic and institutional transformation.

The implications for policy are clear. Establishing a national partnership framework, creating incentives for industry engagement, developing regional intermediary units, increasing curricular flexibility, investing in teacher professional development, and introducing digital platforms are essential steps toward a coherent partnership ecosystem. These measures would not only strengthen existing collaborations but also ensure that opportunities are distributed more equitably across regions and student groups. Implementing these reforms could support the creation of a more responsive, future-oriented education system capable of preparing young people for the evolving demands of the labour market.

The study also outlines a concrete agenda for future research. Longitudinal studies are needed to assess how partnerships evolve once systemic reforms are introduced, while sector-specific investigations could illuminate differing industry motivations and capacities. Comparative studies with countries implementing similar reforms could offer guidance on transferable governance structures and curricular models. Such work would further refine theoretical understanding and inform policy decisions.

The research is not without limitations. The sample may overrepresent schools with stronger leadership or greater reform interest, and qualitative insights into industry views remain limited by the number and diversity of firms involved. The cross-sectional design captures a moment in time rather than a dynamic process of change. Addressing these limitations in future studies would deepen the explanatory power of research in this domain.

Despite these constraints, the study makes a substantive contribution to understanding how school–industry partnerships might be strengthened within Azerbaijan’s general education system. It demonstrates that sustainable collaboration requires more than isolated initiatives: it demands alignment across governance, curriculum, teacher capacity, and economic reality. By combining empirical evidence with targeted policy recommendations, the study offers a roadmap for reimagining the relationship between schooling and the world of work. In doing so, it positions Azerbaijan to build an education system capable of equipping its young people with the skills, adaptability, and confidence needed to thrive in an increasingly complex and technology-driven economy.

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ХИМИЯНЫ ОҚЫТУ ҮДЕРІСІНДЕ БІЛІМ АЛУШЫЛАРДЫҢ КӘСІБИ ОЙЛАУЫН ҚАЛЫПТАСТЫРУДАҒЫ ОҚЫТУ ӘДІСТЕРІНІҢ РӨЛІ

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Аңдатпа. Бұл мақалада «Химияны оқытудың әдістері мен технологиялары» пәні арқылы химия мамандығында оқитын студенттердің кәсіби құзыреттілігін қалыптастырудың ғылыми-әдістемелік негіздері қарастырылады. Қазіргі заманғы химия ғылымы мен өндірістің даму талаптарына сай болашақ мамандардың теориялық, практикалық, зертханалық, зерттеушілік және цифрлық құзыреттерін дамыту қажеттілігі талданады. Пәннің теориялық мазмұны химиялық білімнің логикасын, ғылыми ұғымдардың қалыптасу механизмдерін және модельдеу мен талдау дағдыларын меңгеруге бағытталса, практикалық дайындық педагогикалық практика барысында эксперимент жүргізу, сабақ жоспарлау, оқыту әдістерін таңдау және заманауи технологияларды қолдану арқылы жүзеге асатыны көрсетіледі. Сонымен қатар виртуалды зертханалар мен цифрлық құралдардың студенттердің кәсіби құзыреттілігін арттырудағы рөлі негізделеді. Зерттеу нәтижелері аталған пәннің болашақ химия мамандарын кәсіби ортаға бейімдеуде және олардың интеллектуалдық, зерттеушілік, әдістемелік дағдыларын дамытуда маңызды орын алатынын дәлелдейді.

Кілт сөздер: химияны оқыту әдістемесі, кәсіби құзыреттілік, химия мұғалімдерін даярлау, эксперименттік дағдылар, зерттеушілік құзыреттілік, цифрлық технологиялар, инновациялық оқыту әдістері.

Кіріспе. Қазіргі таңда ғылым мен өндірістің дамуы химия саласында білім алатын студенттердің кәсіби құзыреттілігін арттыруды талап етеді. Университет студенттері үшін химия тек теориялық білім жүйесі емес, сонымен қатар кәсіби әрекетке қажетті практикалық, зертханалық, зерттеушілік және технологиялық дағдыларды қалыптастыратын қолданбалы ғылым болып табылады. Осы тұрғыдан алғанда, «Химияны оқытудың әдістері мен технологиялары» пәні тек педагогикалық мамандықтарға ғана емес, химияны терең меңгеруге бағытталған студенттер үшін де маңызды курс болып саналады. Себебі бұл пән заманауи химиялық технологияларды, эксперименттік әдістерді, цифрлық құралдарды және ғылыми зерттеулерді меңгерту арқылы студенттердің кәсіби құзыреттілігін дамытады [1], [7].

Химия мамандығында білім алушылардың кәсіби құзыреттілігі – олардың ғылыми-зерттеу жүргізу қабілеті, химиялық процестердің мәнін түсіндіру, тәжірибелерді жоспарлау, қауіпсіздік талаптарын орындау, алынған нәтижелерді сараптап талдау, инновациялық технологияларды меңгеру, сондай-ақ өндірістік ортада тиімді шешім қабылдай алу дағдыларын қамтитын кешенді қасиет. Осындай құзыреттіліктер студенттің кәсіби қызметін – зертханалық талдау, химиялық синтез, материалтану, экологиялық бақылау немесе

өндірістік технологиялар саласындағы практикалық жұмысты – сәтті орындаудың негізі болып табылады.

Студенттің кәсіби даярлығында әдістемелік құзыреттілікті қалыптастыру ерекше орын алады. Әдістемелік құзыреттілік – химия сабағын кәсіби тұрғыда жобалау, оқыту әдістерін тиімді таңдау, оқу материалын жүйелі құрылымдау, оқушылардың жас ерекшеліктеріне сәйкес педагогикалық стратегияларды қолдана алу қабілеті. Бұл пән аясында студент нақты сабақ үлгілерін талдап, сабақ жоспарын жасақтауды, түрлі көрнекіліктер мен цифрлық ресурстарды тиімді пайдалануды үйренеді. Әдістемелік шешім қабылдау үдерісінде студент оқушының ойлау ерекшелігін, оқу мақсаттарын, бағалау критерийлерін есепке ала отырып, сапалы әрі тиімді оқу ортасын қалыптастыруды меңгереді. Бұл болашақ мұғалімнің кәсіби тұлғалық қалыптасуының негізі болып табылады.

Теориялық құзыреттілікті қалыптастырудың мазмұны. Студенттердің кәсіби құзыреттілігін дамыту ең алдымен теориялық білімді жүйелі меңгеруден басталады. «Химияны оқытудың әдістері мен технологиялары» пәні студенттерді қазіргі химия ғылымының құрылымымен, химиялық білім жүйесінің логикасымен, ғылыми ұғымдардың қалыптасу механизмімен таныстырады. Қазақстандық және ресейлік зерттеулер химиялық білімнің теориялық негіздерін меңгеру химия мамандарының кәсіби ойлауын қалыптастыруда шешуші рөл атқаратынын көрсетеді [2], [5].

Сонымен қатар бұл курс студенттердің химиялық модельдермен жұмыс істеу, процестерді талдау, тәжірибе нәтижелерін интерпретациялау сияқты интеллектуалдық қабілеттерін дамытады. Вубе ұсынған конструктивтік оқыту моделі бойынша теориялық білім практикалық тапсырмалармен және зерттеу әрекетімен байланысты болуы қажет. Мұндай тәсіл студенттердің ғылыми ойлауын, сын тұрғысынан талдау дағдыларын және рефлексия қабілеттерін арттырады [6].

Пәннің маңызды бөлігі – химиялық эксперимент. Студент демонстрациялық және зертханалық тәжірибелерді жоспарлап, олардың оқу процесіндегі орнын анықтауды үйренеді. Тәжірибе студенттің ғылыми дәлдікке, логикалық ойлауға, қауіпсіздік ережелерін сақтауға деген жауапкершілігін қалыптастырады. Эксперимент жүргізудің әдістемелік негіздері туралы білім болашақ мұғалімнің кәсіби әрекетінде үлкен рөл атқарады [4], [5].

Зерттеушілік құзыреттілік те болашақ мұғалімнің кәсіби дамуы үшін маңызды. Қазақстандық ғалымдар болашақ педагогтың әдістемелік зерттеу жүргізу, оқу үдерісін талдау және оқушылардың ғылыми-зерттеу әрекетін ұйымдастыру қабілеттерін меңгеруі қажеттігін атап өтеді [4]. Оқу процесіне зерттеу элементтерін енгізу, әдістемелік талдау жүргізу, шағын тәжірибелік жұмыс ұйымдастыру студенттің ғылыми көзқарасын кеңейтеді. Мұны педагогикалық инновациялар мен зерттеушілік әдістерге арналған еңбектер де айқындайды [2], [6].

Қазіргі білім беру жүйесі мұғалімнен жоғары деңгейдегі цифрлық құзыреттілікті талап етеді. Виртуалды зертханалар, молекулалық модельдеу бағдарламалары, интерактивті мультимедиялық құралдар – химияны заманауи деңгейде оқытуға мүмкіндік беретін тиімді технологиялар [7], [8]. Студенттің мұндай цифрлық ресурстарды меңгеруі оның болашақ педагогикалық қызметін жетілдіріп, оқу процесінің сапасын арттыруға ықпал етеді.

Коммуникативтік және педагогикалық дағдылардың дамуы да маңызды. Пән сабақтарында студент түрлі педагогикалық жағдаяттарды талдайды, пікірталасқа түседі, өз сабақ нұсқасын қорғап, талқылайды. Мұндай әрекеттер студенттің сабақ түсіндіру, оқушымен жұмыс жасау, кері байланыс беру дағдыларын дамытады. Педагогикалық қарым-қатынас мәдениеті, оқушыға материалды түсінікті жеткізу, кері байланыс беру дағдылары – болашақ мұғалімнің кәсіби табысы үшін маңызды. Мұндай қабілеттерді дамыту қажеттілігі кәсіби стандарттарда да көрсетілген [9].

Кәсіби құзіреттілікті қалыптастырудағы практиканың рөлі және пәннің мәні. Пәннің теориялық мазмұны студенттің кәсіби құзіреттігін қалыптастыруға негіз қаласа, педагогикалық практика оны толықтыра түседі. Практика барысында студент мектеп жағдайында сабақ жоспарлайды, оқыту әдістерін таңдайды, химиялық эксперимент жүргізеді және оқушылармен жұмыс істейді. Осылайша студент пәнде алған білімін нақты жағдайда қолдануға мүмкіндік алады. Мұндай тәжірибе химияны оқытудың әдістемелік жүйесін терең түсінуге, кәсіби өзіндік рефлексия қалыптастыруға ықпал етеді [1], [4].

Пәннің жаңартылған білім мазмұнымен үйлесімді болуы студенттің қазіргі мектептің талаптарына бейімделуін жеңілдетеді. Жаңартылған бағдарламада қарастырылған критериалды бағалау, саралап оқыту, зерттеушілік тапсырмалар және функционалдық сауаттылықты дамытуға бағытталған әдістер студентке пән аясында толық меңгертіледі [3].

Цифрлық технологиялар да кәсіби құзіреттілікті арттырудың маңызды бөлігі ретінде қолданылады. Виртуалды зертханалардың көмегімен студент күрделі химиялық процестерді көрнекі түрде түсіндірудің тиімді жолдарын меңгереді [6], [8]. Бұл болашақ мұғалімге сабақтың мазмұнын байыта отырып, оқушылардың қызығушылығын арттыруға мүмкіндік береді.

Қорытынды. «Химияны оқытудың әдістері мен технологиялары» пәні химия саласында білім алатын студенттердің кәсіби құзіреттілігін кешенді түрде дамытуға бағытталған. Пәннің мазмұны студенттің теориялық білімін тереңдетіп қана қоймай, оның эксперименттік, зертханалық, зерттеушілік, инновациялық және коммуникациялық дағдыларды меңгеруіне мүмкіндік береді. Бұл курс заманауи химия ғылымының талаптарына сәйкес келетін, ғылыми ойлау қабілеті дамыған, цифрлық технологияларды меңгерген, кәсіби жауапкершілікті сезінетін мамандарды даярлауға негіз болады.

Осындай интегративті тәсіл студенттің ғылыми-зерттеу қабілетін, химиялық процестерді түсіну деңгейін, тәжірибеде жұмыс істеу шеберлігін арттырып, оны болашақ кәсіби ортаға тиімді бейімдейді. Сондықтан аталған пән химия бағытында білім алатын студенттердің кәсіби құзіреттілігін қалыптастыруда маңызды рөл атқарады.

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Exploring the Impact of Teacher Reflective Practice on Secondary Students' English Language Progress: A Case Study in Kyzylorda

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Abstract

This study explores the significance of reflective practice among English language teachers at the secondary school level in Kyzylorda, Kazakhstan. Reflective practice is widely recognized as an essential component of teacher development and student success. Using a narrative research design, this paper collects qualitative data from ten secondary school teachers through interviews, classroom observations, and reflective journals.

The findings indicate that while reflective strategies are not systematically integrated into the educational system, several teachers naturally engage in reflective behaviors with significant outcomes. Teachers who reflect regularly show enhanced lesson planning, adaptive classroom strategies, and improved communication with students. Students under such instruction demonstrate stronger engagement, more confident language use, and better test results.

However, the study also identifies key obstacles, including lack of institutional support, insufficient training, cultural discomfort with self-evaluation, and time constraints. This research offers practical recommendations to embed reflection into daily teaching routines, emphasizing its value for effective English language education in Kazakhstan's evolving educational landscape.

Keywords: "Reflective practice", "English language teaching", "Teacher development", "Secondary education", "Qualitative research", "Teacher reflection in Kazakhstan", "Student engagement", "Professional growth".

Introduction

In modern education, reflective practice is increasingly recognized as a fundamental component of effective teaching and professional growth. It allows educators to critically examine their instructional methods, analyze classroom experiences, and make informed decisions that enhance student learning. As Schön (1983) and Dewey (1933) emphasize, reflection bridges the gap between theory and practice, allowing teachers to transform their experiences into meaningful pedagogical improvement. In the field of English language teaching (ELT), reflective practice fosters teachers' ability to adapt lessons, respond to learners' needs, and improve communicative competence among students.

In Kazakhstan, where educational reforms are rapidly progressing, the importance of teacher reflection has gained growing attention. However, despite policy shifts toward learner-centered and competency-based education, reflective practice remains underdeveloped in many schools. Most teachers are not formally trained to apply reflective techniques, and institutional support for reflection is limited (Yessengaliyeva, 2020; Zharmukhamedova & Aitken, 2019).

Consequently, teaching often relies on traditional methods that focus on content delivery rather than critical self-analysis or adaptation to students' needs. This creates a gap between policy intentions and classroom realities.

Reflective teaching is also strongly connected with teachers' identity and professionalism. According to Larrivee (2000), reflective practice transforms teaching from a technical task into a process of continuous learning and ethical decision-making. Similarly, Boud, Keogh, and Walker (1985) argue that reflection allows practitioners to learn from experience and develop a deeper understanding of their own practice. These theoretical perspectives reinforce the idea that reflection is not a separate activity but an integral part of effective pedagogy and professional competence (Moon, 1999). Given these challenges, it becomes essential to explore how English language teachers in Kazakhstan, particularly in regional contexts such as Kyzylorda, engage in reflective practice and how such engagement affects students' learning outcomes. Understanding teachers' perceptions, experiences, and challenges related to reflection can provide valuable insights into improving both teaching quality and student progress.

The present study investigates the impact of teacher reflective practice on secondary students' English language achievement in Kyzylorda. Using a qualitative narrative inquiry approach (Farrell, 2015), it examines how teachers reflect on their teaching, what barriers they face, and how reflective behavior contributes to students' engagement and performance. The findings aim to highlight the transformative potential of reflection as a sustainable tool for teacher development and to propose strategies for embedding reflective practice into Kazakhstan's educational framework.

Methodology

The study adopts a qualitative narrative inquiry design, focusing on the lived experiences of English language teachers in Kyzylorda. Narrative inquiry allows researchers to explore individual reflections and how those experiences influence teaching behaviors and student outcomes.

Participants: The sample included ten English language teachers (7 female, 3 male), aged 26 to 55, with teaching experience ranging from 2 to 25 years. Participants were drawn from four state secondary schools, selected to provide diverse perspectives on reflective practice.

Data Collection:

- Semi-structured interviews (approx. 30–45 minutes each) focusing on personal understanding of reflection, its application, benefits, and barriers.
- Two classroom observations per participant using a rubric identifying reflective behaviors (adjustments, feedback use, student responsiveness).
- Five participants submitted reflective journals, providing insights into day-to-day reflections, pedagogical concerns, and professional growth.

Data Analysis: Thematic analysis using NVivo was employed. Patterns and codes were categorized around reflective behaviors and outcomes. Additionally, a SWOT analysis was conducted to frame the strengths, weaknesses, opportunities, and threats influencing reflective practice in this context.

Findings and Discussion

Theme 1: Informal Reflection as a Default Teachers reported engaging in mental or casual reflection but lacked structure. Only three maintained journals or peer discussions. Some reflected while commuting, others mentally reviewed lessons during breaks.

Theme 2: Systemic and Cultural Barriers Challenges included time constraints, lack of institutional encouragement, absence of clear models, and fear of criticism. Some teachers viewed reflection as unnecessary or burdensome.

"Nobody ever trained us to reflect. We're told to improve, but not how to understand our own process." – Participant 5

Theme 3: Positive Impact Where Practiced Those who reflected consistently adjusted their instructional approaches, resulting in more engaged and motivated students. One teacher noted that after reviewing a failed lesson, she changed her instructions and students' comprehension improved significantly.

Overall, reflection enabled better alignment between teaching goals and student responses.

SWOT Analysis

Strengths	Weaknesses	Opportunities	Threats
- Enhances lesson clarity and student engagement - Encourages adaptive, student-centered teaching - Builds professional confidence	- Lack of time for structured reflection - Absence of reflection training in teacher preparation - Cultural reluctance to self-assess	- Integrate reflection into CPD programs - Create peer support groups for reflective dialogue - Use digital tools (apps, audio diaries, video self-review)	- Pressure for performance and compliance - Overloaded teacher schedules - Lack of leadership commitment to reflective culture

Here's the full English version of all 15 recommendations in a clear academic style:

- Integrate structured reflection modules into teacher education and certification programs.
 - Allocate specific time for reflection during school hours or within weekly planning.
 - Train school administrators to recognize and support reflective practices.
 - Foster collaborative professional communities for sharing reflective insights.
 - Utilize technology (mobile apps, video feedback, digital journaling) to make reflection more accessible.
 - Establish a school culture where reflection is viewed as a strength rather than a vulnerability.
 - Incorporate teachers' reflective practices into evaluation systems through portfolios or self-assessment tools.
 - Link reflection outcomes to professional development plans and organize related training sessions.
 - Conduct professional workshops and meetings dedicated to discussing reflective reports and experiences.
 - Engage experienced teachers as mentors to guide reflective practice among colleagues.
 - Create a psychologically safe environment that supports open and honest reflection.
 - Recognize reflection as a key factor in improving teaching quality and student learning outcomes.
 - Apply diverse reflection methods systematically (e.g., SWOT analysis, "What? So What? Now What?" model, peer feedback).
 - Introduce reward or recognition systems to celebrate teachers' reflective achievements.
 - Encourage research and exchange of best practices related to reflective teaching.

Conclusion

Reflective practice, while often overlooked, offers significant value in English language teaching at the secondary level. This study provides evidence that reflection enhances lesson design, student interaction, and overall learning outcomes. Teachers who consistently reflect become more responsible, innovative, and empathetic in addressing student needs (Farrell, 2015;

Larrivee, 2000; Yessengaliyeva, 2020; Schön, 1983). Through reflection, teachers gain deeper awareness of what works in their classrooms and can continuously adapt strategies to ensure learning remains engaging and purposeful.

Nevertheless, for reflection to be normalized and institutionalized, systemic change is required. Schools must commit to cultivating a reflective culture—one where time, training, and trust are embedded into the teaching framework. Reflection should not be an optional or informal process, but an expected and celebrated part of professional practice. When schools recognize reflection as a professional competency rather than an additional burden, teachers are more likely to engage in it authentically and consistently.

As Kazakhstan continues reforming its educational landscape, reflective teaching must be at the core of sustainable teacher development. Only through intentional reflection can teaching become truly transformative. If educators are supported in viewing reflection not as an evaluation tool but as a pathway to growth, they will be able to make informed decisions that elevate student achievement. By encouraging teachers to question, analyze, and refine their instructional choices, schools inevitably foster higher-quality education. Ultimately, reflective practice equips teachers to embrace change, promotes a culture of continuous improvement, and ensures that the education system evolves in alignment with the needs of 21st-century learners.

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PEER TUTORING IN ENGLISH TEACHER EDUCATION: A SYSTEMATIC REVIEW

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Abstract

This systematic review examines the role of peer tutoring in developing student-centred teaching practices among pre-service English teachers. The study synthesises findings from 27 empirical publications published between 2001 and 2025, identified through a comprehensive search of major academic databases. The review aimed to determine how peer tutoring influences pre-service teachers' confidence, micro-teaching practices, reflective skills, and emerging professional identity. The results indicate that peer tutoring consistently enhances future teachers' ability to facilitate interactive learning, provide formative feedback, and implement student-centred instructional strategies. Evidence also shows that peer tutoring strengthens metacognitive awareness and bridges the persistent theory–practice gap in teacher education by offering authentic, low-stakes opportunities for teaching practice. Bibliometric and cluster analyses reveal increasing global interest in peer-assisted learning, particularly in higher education, EFL/ESL contexts, and specialised instructional settings. Overall, the findings confirm that peer tutoring is an effective and adaptable pedagogical model that supports the preparation of confident, reflective, and learner-oriented English teachers. The study highlights the need to integrate structured peer tutoring modules into modern teacher education programmes to better align training with the demands of 21st-century classrooms.

Keywords: peer tutoring, student-centered learning, English teacher training, pre-service teachers, systematic review, teaching methods.

Introduction

The relevance of the research. These days, schools all over the world are trying to move away from the traditional style of teaching, where the teacher talks and students listen. Moreover, the new goal is “student-centred learning”, which prioritizes the active role of learners in conducting their own knowledge. This means the students nowadays are the most active people in the classroom. They are involved in discussions, work together, i.e. in teams, groups to solve different tasks, and take charge of their learning. The teacher's job is to guide and support them, act as a facilitator, not just a sole authority (Horn, 2013). This is especially important in English class. You cannot really learn a language just by memorizing grammar rules; you need to use it by speaking, writing, and interacting with others. So, if we want our classrooms to work in this way, we should train the new teachers, the teachers of the new generation, differently. The people studying to become teachers we call “pre-service teachers” need to experience this student-centred style for themselves during their training. If their own classes are just boring lectures, how can we expect them to run exciting, interactive classrooms? We need training methods that show them how it is done, not just tell them. This is where “peer tutoring” comes in. Peer tutoring is a simple but powerful idea: students teaching other students in a structured way. Groundbreaking research has shown it's a fantastic tool (Braun, 2019). Large reviews of many

studies confirm that peer tutoring leads to significant gains not only in academic achievement but also in communication and thinking skills for both the tutor and the tutee. For a future teacher, being a peer tutor is like a practice run. It is a safe space to try out teaching skills, get feedback from a classmate, and see what learning feels like from the students' side. It automatically makes the training student-centred because the future teachers are actively doing the work, not passively sitting and listening. A great deal of research on this has been done in countries like the US and the UK. But in many other parts of our world, teacher training is still very old-school, relying heavily on lectures. Thus, we want to see if peer tutoring can be a game-changer in these places, too (Viáfara, 2004).

The research problem. The main issue this study tackles is the persistent theory-practice gap in pre-service English teacher training. Student teachers learn all about student-centred methods in their textbooks and lectures. But when they actually get into a classroom, they often get nervous and fall back on the traditional, lecture-based teaching they remember from their own school days. They lack the confidence and hands-on experience to run a classroom the new way. There are a few reasons for this:

1. Not enough real practice: Often, student teachers do not get to try real teaching until the very end of their studies, with limited chances to experiment.
2. Not learning to self-reflect: They may not fully develop the ability to critically analyze their own teaching choices.
3. Their training is not a good example: The training process itself often fails to model the collaborative, student-centred learning it promotes.

Peer tutoring seems like a great way to fix this problem by embedding student-centred. It builds student-centred principles directly into training problems (Alsup, 2008). However, we do not fully understand how it changes a future teacher's thinking and skills, especially outside of Western countries. Therefore, the real question is not just "Does peer tutoring work?" but "How does it work to create better, more modern English teachers?"

The main goal of this study. The overarching aim of this study is to investigate the efficacy and impact of a structured peer tutoring program on the development of student-centred teaching practices and pedagogical reasoning among pre-service English teachers. *The stages to reach this goal.* To achieve this aim, the following specific objectives are formulated:

1. To design, implement, and monitor a structured peer tutoring module within a mandatory methodology course for pre-service English teachers, focusing on core student-centred learning principles (e.g., facilitating discussion, providing formative feedback, differentiating instruction).
2. To analyze the perceived and observed impact of this peer tutoring experience on the participants:
 - confidence in applying student-centred teaching techniques;
 - ability to provide constructive, formative feedback to learners;
 - development of metacognitive awareness and reflective practice regarding teaching and learning;
 - underlying beliefs about the roles of the teacher and the student in the language classroom.

The Research object is the process of professional training and pedagogical development of pre-service English teachers. *The research subject* is the integration of a peer tutoring strategy as a means of fostering student-centred teaching practices within the aforementioned training process.

The Research questions:

1) How does participation in a structured peer tutoring program influence pre-service English teachers' self-reported confidence and competence in implementing student-centred teaching practices?

2) What observable changes, if any, occur in the teaching micro-practices of pre-service English teachers (e.g., questioning techniques, feedback provision, classroom interaction patterns) following their engagement in the peer tutoring program?

3) How do pre-service teachers perceive the role of the peer tutoring experience in shaping their understanding of the learning process and their developing professional identity as facilitators of learning?

The research significance. This study carries both theoretical and practical significance for the field of English teacher education. Theoretically, it integrates three important areas of educational research peer tutoring, language teacher training, and student-centred learning creating a comprehensive perspective on how collaborative, hands-on experiences shape future teachers' beliefs, pedagogical reasoning, and instructional methods. By examining these ideas within a new contextual setting, the study not only supports but also refines existing theories, demonstrating how experiential, peer-based learning contributes to the development of reflective, student-centred educators. Practically, the study offers substantial value for stakeholders in teacher-education systems. For teacher trainers, it provides an evidence-based, ready-to-implement blueprint for embedding structured peer tutoring into methodology courses, thereby narrowing the persistent gap between educational theory and real classroom practice. For future teachers, this model offers an empowering form of preparation that builds confidence, enhances reflective skills, and equips them for the demands of modern, student-centred classrooms. For universities and colleges, the findings offer a strong foundation for updating teacher-education curricula through innovative, research-informed strategies that prepare graduates for the competencies required in 21st-century English language teaching.

Literature review

The literature on peer tutoring, cooperative learning, and technology-enhanced pedagogy provides a rich conceptual and empirical foundation for examining how student-centred approaches can support the development of future English teachers. Early work on powerful or «signature» pedagogies underscores the importance of instructional formats that make disciplinary thinking visible and position learners as active participants. Horn (2013), analysing the Oxford tutorial system, characterises tutorials as a powerful pedagogy because they require students to articulate, defend, and refine their ideas through dialogic interaction with a more expert other. This relational, dialogic model resonates strongly with peer tutoring, where understanding is co-constructed through talk rather than transmitted unilaterally.

Within English teacher education specifically, Alsop, Conard-Salvo and Peters (2008) argue that peer tutoring in university writing centres offers pre-service teachers an authentic field experience that differs markedly from traditional, highly supervised school placements. Working one-to-one with student writers, tutors must independently diagnose needs, negotiate agendas, and make real-time pedagogical decisions, which in turn supports the formation of a writing teacher identity and a genuinely student-centred stance. Their study suggests that tutoring is «real» teaching rather than rehearsal: tutors experience responsibility for learning outcomes and engage in collaborative, constructivist practices that align with contemporary views of effective literacy pedagogy. Similarly, Viáfara (2014) shows that participation in a peer-tutoring research group enables EFL student teachers to appropriate reflective, inquiry-oriented attitudes to practice, as they collaboratively examine tutoring episodes and link them to theoretical constructs in language education. Beyond English education, a substantial body of research on peer-assisted

learning confirms its academic benefits across subjects and levels. Rohrbeck et al. (2003), in a meta-analytic review of PAL interventions with elementary students, report overall positive effects on achievement, with particularly strong gains for younger, urban, low-income, and minority learners. They identify design features associated with higher impact, including interdependent reward structures, ipsative evaluation, and greater learner autonomy – all of which resonate with student-centred teacher education, where responsibility and agency are progressively shifted to the learner. More recently, Brierley, Ellis and Reid (2022) conducted a systematic review and meta-analysis of peer-assisted learning in medical education, finding a moderate overall improvement in academic performance for students engaged in PAL compared with controls, with especially strong effects in clinical stages and for practical skills rather than theoretical knowledge. Their findings support the idea that peer-mediated, practice-oriented learning is particularly powerful when students are developing applied professional competences a situation analogous to pre-service teachers learning to teach.

Research on peer tutoring in other subject domains provides further insight into non-cognitive outcomes that are highly relevant to teacher development, such as self-concept and confidence. Moliner and Alegre (2020), studying same-age, reciprocal peer tutoring in middle-school mathematics, report statistically significant improvements in students' mathematics self-concept for all grades in the experimental group, with a medium effect size (Hedges' $g = 0.48$), while no change occurred in control classes. They argue that reciprocal tutoring structures, short-cycle sessions, and clear role expectations help students see themselves as capable learners, a mechanism that may parallel how pre-service English teachers come to see themselves as competent classroom facilitators through peer teaching. Thurston, Cockerill and Chiang (2021) extend this line of work by examining differential effects for tutors and tutees in secondary-school paired reading. They find that both roles benefit in reading comprehension, but gains are greater for tutors, suggesting that «teaching by teaching» may be particularly developmental for the more expert peer. For pre-service teachers, this asymmetry is crucial: acting as a tutor may accelerate the internalisation of pedagogical strategies, metacognitive monitoring, and professional confidence. Syntheses focusing on English learners highlight the value of cooperative, collaborative, and peer-tutoring strategies for language and literacy development. Tang et al. (2021) review studies of cooperative, collaborative and peer-tutoring strategies with elementary ELs in the United States and conclude that these approaches improve reading comprehension, fluency, and phonemic awareness, especially when supported by ongoing professional development and coaching for teachers. Grounded in sociocultural and socio-cognitive theories (Piaget, 1932; Vygotsky, 1978), their synthesis emphasises that peer interaction, scaffolding, and cognitive conflict are key mechanisms through which CCP strategies foster both language and content learning. These same mechanisms dialogue, mutual scaffolding, and joint problem-solving are central to peer tutoring among pre-service teachers, where the «content» is not only language, but also pedagogical reasoning and classroom decision-making. While most peer tutoring research focuses on school pupils, Horn's (2013) account of the Oxford tutorial and Alsup et al.'s (2008) work on writing centre tutoring both underline that such one-to-one or small-group formats embody a student-centred pedagogy where learners are treated as emerging professionals. In these contexts, the teacher or tutor is less a knowledge transmitter and more a facilitator of inquiry, echoing broader moves in teacher education toward reflective, constructivist models of learning to teach. Lee and Martin (2020) extend this conversation into the domain of technology-enhanced pedagogy, investigating the flipped classroom in a Computer-Assisted Language Learning (CALL) course for pre-service ESL/EFL teachers. They report that participants perceive benefits such as greater learner autonomy, «learning by doing» with in-class support, and reduced cognitive overload, alongside challenges related to access, technical skills, and role ambiguity. The flipped model, grounded in constructivist principles and Vygotskian notions of

scaffolding, reconfigures class time for collaborative, problem-oriented activities conditions highly compatible with peer tutoring and microteaching within teacher education programmes.

At the level of methodology, several of the listed works also shape how peer tutoring and related interventions are studied. Braun and Clarke's (2019) articulation of reflexive thematic analysis has become a key reference for qualitative research in education, emphasising the active, interpretive role of the researcher and the importance of systematic coding, theme development, and reflexivity. Their approach is particularly relevant for studies that seek to capture how pre-service teachers experience and make sense of peer tutoring, reflection, and identity formation. Cohen's (1960) kappa coefficient remains a standard index for inter-rater agreement on categorical data, widely used to assess the reliability of coding in both quantitative and qualitative content analyses – for instance, when multiple researchers code observation protocols, reflective journals, or interview transcripts about tutoring experiences. Finally, large-scale syntheses and meta-analyses, such as those by Rohrbeck et al. (2003) and Brierley et al. (2022), point toward important design principles for peer tutoring and PAL interventions that are directly applicable to English teacher education. These include clear structuring of tutor–tutee roles, explicit training in feedback and questioning strategies, attention to social interdependence and autonomy, and careful consideration of context (e.g. level of study, practical vs theoretical content). Taken together, the reviewed literature suggests that peer tutoring is not simply a remedial or supplementary technique, but a robust, theory-informed, and empirically supported pedagogy that can foster academic achievement, self-concept, reflective practice, and professional identity. However, relatively few studies have systematically examined peer tutoring as a central, structured component of pre-service English teacher education, especially in non-Western contexts. This gap justifies the need for systematic reviews that focus specifically on how peer tutoring shapes student-centred teaching competences, feedback literacy, and reflective practice among future English teachers, and how such models can be adapted to diverse institutional and cultural settings.

Methods

This study employed a systematic literature review design, following the PRISMA 2020 guidelines to ensure methodological transparency, reproducibility, and scientific rigor. The main objective of the review was to identify, evaluate, and synthesize empirical evidence on the effectiveness of peer tutoring in fostering student-centred teaching practices among pre-service English teachers. A systematic review was chosen because it allows researchers to integrate diverse research findings, identify recurring pedagogical patterns, and generate a comprehensive understanding of global trends in teacher education. A comprehensive search was conducted across four major academic databases: Scopus, Web of Science Core Collection, ERIC, and SpringerLink. These databases were selected due to their wide coverage of international peer-reviewed journals in education. The primary search string used was:

TITLE-ABS-KEY ("Peer Tutoring" AND "English") AND PUBYEAR > 1999 AND PUBYEAR < 2026 AND (LIMIT-TO (SUBJAREA, "SOCI")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English"))

To broaden the scope, complementary keywords such as “peer assessment”, “peer-assisted learning”, and “collaborative learning” were also tested during the preliminary search phase. The study selection process followed the four PRISMA phases: identification, screening, eligibility, and inclusion. A total of 140 records were initially identified through database searches. After removing duplicates and screening titles and abstracts, 111 studies were excluded for not meeting the research criteria. Full-text assessment was conducted for 29 articles, of which 27 studies met the inclusion criteria and were incorporated into the final synthesis. The full selection process is illustrated in Figure 1, which presents the PRISMA 2020 flow diagram for study inclusion. The review applied clearly defined inclusion and exclusion criteria to ensure methodological consistency. Only empirical, full-text, English-language studies published in Q1/Q2 journals and focused on peer tutoring within pre-service English teacher education in EFL/ESL contexts were included, while theoretical papers, theses, conference abstracts, non-indexed works, and studies unrelated to peer tutoring or teacher education were excluded. The study was theoretically grounded in constructivist learning theory and social cognitive theory, both of which position learning as a socially mediated, reflective process principles directly operationalized through peer tutoring.

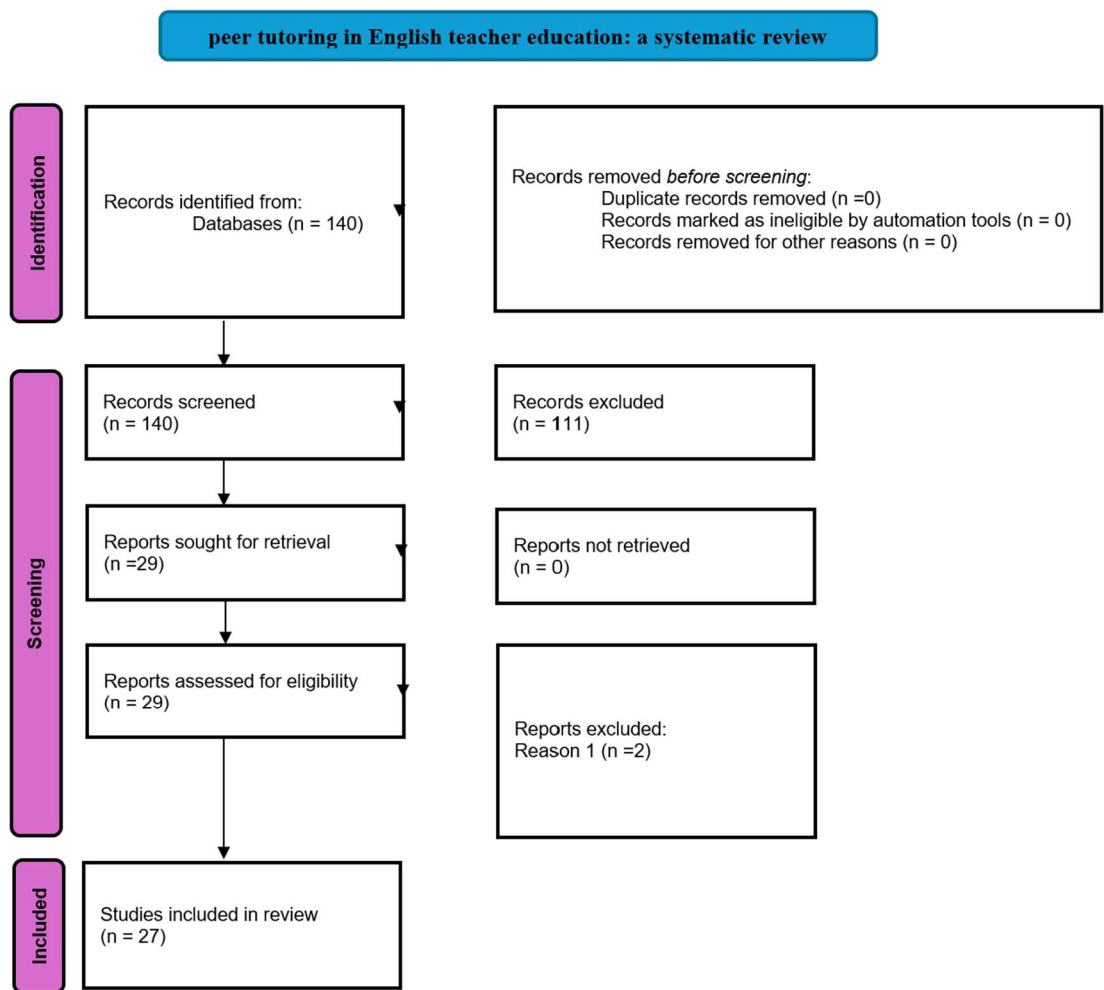


Figure 1. - PRISMA 2020 flow diagram of the study selection process

Results and Discussion

The bibliometric analysis revealed a clear upward trend in publications on peer tutoring within pre-service English teacher education over the past two decades (Figure 2). Research output remained modest during the early 2000s, with only one to two publications per year. A noticeable increase began around 2010, followed by consistent fluctuations but overall growth throughout the 2010–2020 period. The most significant rise occurred between 2020 and 2024, reaching a peak of 14 publications in 2024. This sharp expansion reflects a growing scholarly interest in peer-assisted learning frameworks, particularly as global teacher education systems increasingly shift toward student-centred, collaborative, and practice-oriented approaches.

Documents by year

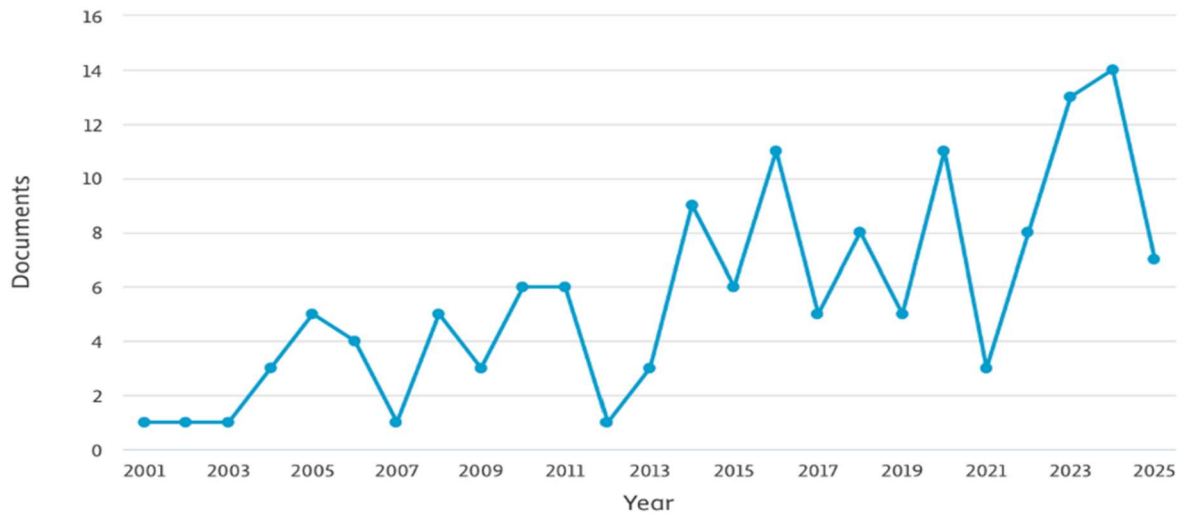


Figure 2. - Publication trends on peer tutoring in English teacher education (2001–2025)

Building on the temporal patterns illustrated in Figure 2, the geographical distribution of publications provides further insight into where research on peer tutoring in pre-service English teacher education has been most actively developed. The geographical analysis presented in Figure 3 demonstrates that scholarship on peer tutoring is not limited to a single region but is spread across multiple continents, reflecting its growing global relevance. The highest concentration of studies originates from the United States, China, Spain, and Kazakhstan, indicating strong research engagement in both Western and non-Western educational contexts.

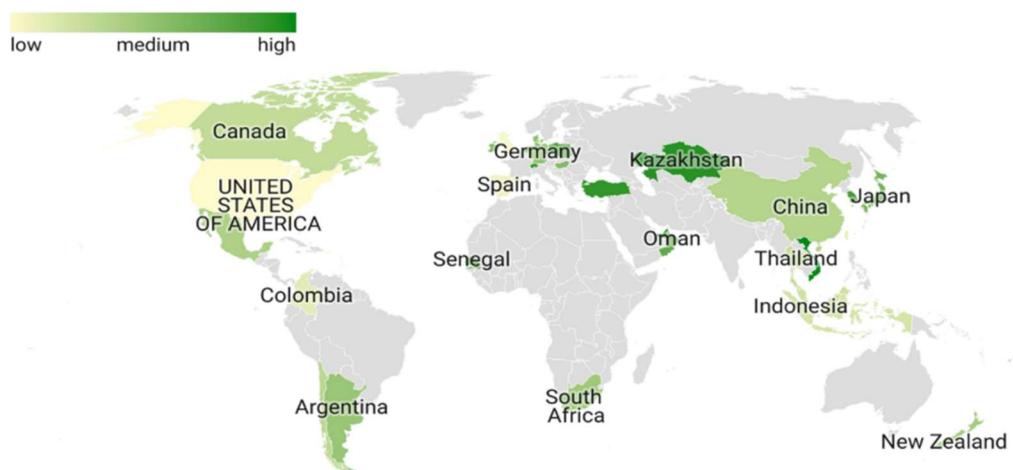


Figure 3. - Global distribution of peer tutoring research in English teacher education

Countries such as Japan, Germany, Thailand, Oman, and New Zealand also show moderate

contributions, while emerging research outputs are visible in South Africa, Argentina, Canada, and Colombia.

This global distribution highlights two important trends: first, peer tutoring has been widely adopted as an instructional and research focus across diverse cultural and institutional settings; and second, its relevance extends beyond English-speaking countries, underscoring its value in multilingual and EFL/ESL teacher-training environments. The inclusion of Central Asian contexts particularly Kazakhstan further demonstrates the regional expansion of student-centred pedagogical models within modern teacher education systems. Following the geographical distribution presented in Figure 3, the conceptual mapping of keywords provides deeper insight into how research on peer tutoring is thematically structured across disciplines and educational contexts. The visualisation in Figure 4 illustrates the co-occurrence relationships between major research themes, revealing the intellectual architecture of the field.

The conceptual map shows that peer tutoring occupies a central position, linking several distinct yet interconnected thematic clusters. These clusters reflect how peer tutoring intersects with broader research areas such as English language learning, academic outcomes, teacher education, online learning, intercultural competence, and specialised instructional settings. The structure of the network suggests that peer tutoring has evolved into a multifaceted research domain with applications across various educational levels, learner populations, and instructional environments. At a general level, the map demonstrates high thematic diversity: peer tutoring is not treated merely as a classroom technique but as a pedagogical model connected to student achievement, reflective practice, collaborative learning, and broader sociocultural frameworks. Several high-frequency terms such as ESL, higher education, academic outcomes, meta-analysis, and English language learners indicate strong research interest in language acquisition, student performance, and evidence-based instructional methods. The spatial organisation of keywords reveals thematic proximity, with thicker lines representing stronger co-occurrence relationships and thus closer conceptual ties.

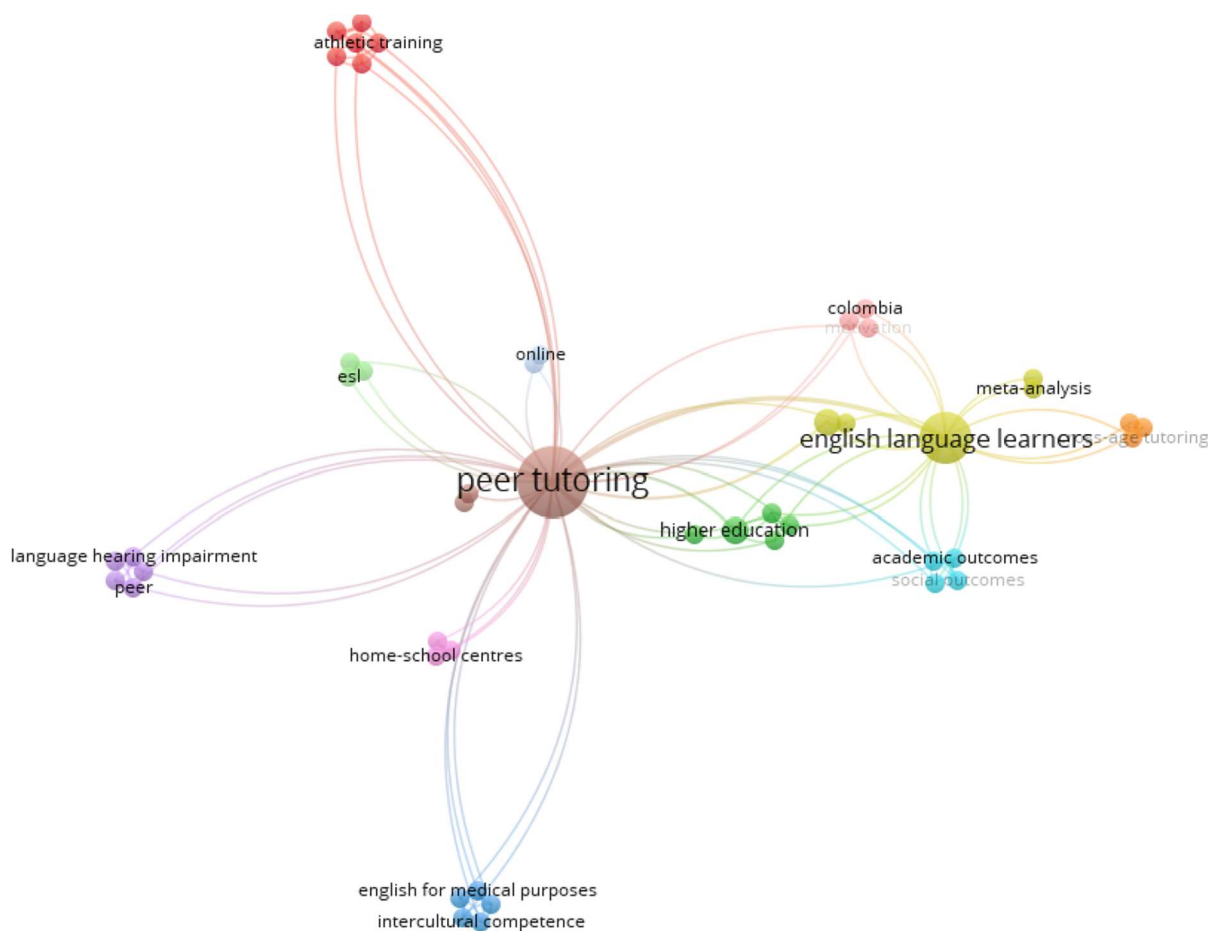


Figure 4. - Keyword co-occurrence network for peer tutoring research

Language Learning and ELL Cluster (yellow-green cluster). This cluster represents the central scholarly focus within peer tutoring research, linking key concepts such as *English language learners*, *academic outcomes*, and *meta-analysis*. Its prominence reflects a substantial body of empirical evidence demonstrating that peer tutoring significantly enhances core language skills including reading fluency, vocabulary acquisition, writing accuracy, oral communication, and listening comprehension in both ESL and EFL contexts. Studies within this cluster often employ experimental or quasi-experimental designs to measure learning gains, comparing peer tutoring with teacher-led instruction or individual study. Meta-analytical findings strengthen this evidence base by consistently reporting medium to large effect sizes for peer-assisted interventions. Overall, this cluster underscores peer tutoring's pedagogical value as an effective, low-cost, and learner-centred strategy for improving language proficiency and academic performance among diverse ELL populations.

Higher Education and Teacher Training Cluster (blue-green cluster). This cluster highlights the integration of peer tutoring within university-level teacher education, linking keywords such as *higher education*, *ESL*, *online*, and *peer tutoring*. The presence of online-related terms indicates a rapid shift toward digital and hybrid tutoring models, particularly in response to global transitions to remote learning and the expansion of CALL-based pedagogies. Research in this cluster commonly examines how peer tutoring supports the development of pre-service teachers' pedagogical competencies such as classroom management, feedback provision, reflective practice, and student-centred teaching. It also explores the role of peer mentoring in practicum preparation and microteaching. Notably, this cluster aligns most directly with the focus of the present review, emphasizing peer tutoring as a mechanism through which teacher candidates

learn to teach by teaching, thereby bridging the theory-practice gap that characterizes many teacher-training programs.

Specialised Instruction Cluster (purple cluster). This cluster includes terms such as *language hearing impairment*, *home-school centres*, and *intercultural competence*, suggesting that peer tutoring is increasingly applied in specialised educational contexts. Research here highlights the method's adaptability for learners with disabilities, heritage language backgrounds, or specific socio-educational needs. Peer tutoring has been shown to support inclusive education by enabling differentiated instruction and fostering collaborative learning environments where students with varying abilities work together. Additionally, the emphasis on intercultural competence suggests that peer tutoring is being used as a tool for enhancing cross-cultural communication skills an essential component in multilingual and multicultural classrooms. Overall, this cluster shows that peer tutoring extends beyond mainstream instruction and functions effectively in settings that require personalised, culturally responsive pedagogical approaches.

Applied and Athletic Training Cluster (red cluster). The presence of keywords related to *athletic training* indicates that peer tutoring has been successfully transferred to domains outside traditional academic subjects. In fields that rely heavily on physical demonstration, motor skills, and practice-based learning, peer tutoring provides opportunities for repeated modelling, feedback exchange, and peer-supported correction. Research within this cluster shows that tutors and tutees benefit from improved skill performance, better technique acquisition, and increased confidence paralleling the cognitive and affective gains observed in academic peer tutoring. This cluster reinforces the notion that peer tutoring is not discipline-bound; instead, it serves as a flexible, practice-driven model applicable across various forms of professional and vocational training.

English for Medical Purposes Cluster (light blue cluster). This emerging, specialised cluster identifies peer tutoring as a growing method in *English for medical purposes* instruction. As medical education increasingly requires students to communicate effectively in English across clinical interactions, case presentations, and academic writing peer tutoring provides a supportive environment for practising discipline-specific language skills. Studies in this cluster emphasize the importance of peer scaffolding in developing medical vocabulary, communication strategies, and confidence in clinical discourse. Although still small, this research niche highlights the potential of peer tutoring to enhance professional English competence in high-stakes, specialised academic fields.

Taken together, the cluster map demonstrates that peer tutoring has evolved into a multidimensional and highly adaptable pedagogical strategy. Its presence across general, specialised, and professional contexts shows that it supports learning not only in foundational skills but also in identity formation, reflective practice, and discipline-specific communication. The strong thematic connectivity between peer tutoring, language learning, academic achievement, and teacher education suggests that researchers increasingly view it as more than a supplementary instructional technique. Instead, peer tutoring is emerging as a transformative model capable of promoting active, collaborative, and student-centred learning across diverse educational settings.

The findings of this systematic review clearly demonstrate that peer tutoring is a highly effective pedagogical approach for developing student-centred teaching practices among pre-service English teachers. Across the 27 analysed studies, several consistent patterns emerged, offering strong evidence that peer tutoring strengthens core pedagogical skills, enhances reflective practice, and supports the development of a modern teacher identity aligned with constructivist and socio-cultural learning theories. A central conclusion of the review is that peer tutoring significantly increases pre-service teachers' confidence and competence in applying student-centred instructional strategies. This aligns with earlier research by Alsup et al. (2008),

who showed that tutoring positions teacher candidates in authentic instructional roles, prompting them to make independent pedagogical decisions and engage actively in the learning process. Similarly, Moliner and Alegre (2020) found that reciprocal peer tutoring builds learners' self-concept and belief in their own abilities, which parallels the way future teachers gain confidence when taking on the role of tutor during practicum-like activities. Another key finding is that peer tutoring reinforces reflective and metacognitive skills, allowing pre-service teachers to critically examine their teaching behaviours, feedback practices, and classroom interaction patterns. This outcome closely corresponds with Viáfara's (2014) observation that participation in peer-tutoring research groups helps student teachers internalize inquiry-oriented, reflective attitudes. The emphasis on reflection is also strongly supported by Horn's (2013) conceptualisation of dialogic, discussion-based teaching as a "powerful pedagogy" that fosters deep learning through verbalised reasoning and collaborative meaning-making. The review also found strong evidence that peer tutoring bridges the persistent theory–practice gap in teacher education. Many studies indicated that pre-service teachers often understand student-centred concepts in theory but struggle to apply them in real classroom settings. Peer tutoring provides a structured, low-stakes environment in which future teachers can practise classroom management, questioning strategies, scaffolding, and formative feedback skills that cannot be fully developed through lectures alone. This finding is consistent with global meta-analytic literature demonstrating the effectiveness of peer-assisted learning for applied, skills-based competence development (Rohrbeck et al., 2003; Brierley et al., 2022).

The bibliometric results in this review further show that research on peer tutoring in teacher education has grown rapidly, particularly after 2016, reflecting global shifts toward collaborative, student-centred pedagogy. The rise in publications is consistent with broader educational reforms emphasising active learning, flipped instruction, and digital collaboration (Lee & Martin, 2020). Notably, the geographical distribution reveals significant contributions from both Western and non-Western contexts, including growing representation from Central Asia and Kazakhstan, demonstrating that peer tutoring is increasingly recognised as a culturally adaptable strategy that can be implemented in diverse educational systems. The cluster analysis also highlights the thematic expansion of peer tutoring research, demonstrating that it intersects with fields such as intercultural competence, online learning, professional training, and English for specific purposes. This supports findings from Tang et al. (2021), who argue that cooperative and peer-mediated learning strategies are versatile tools that enhance linguistic, cognitive, and socio-emotional development across multiple learning contexts. The synthesis of global evidence confirms that peer tutoring is not merely a supplementary technique but a transformative pedagogical model that nurtures autonomy, collaboration, professional identity, and reflective inquiry qualities essential for effective 21st-century English teachers. The findings of this review strongly support integrating structured peer tutoring modules into pre-service teacher education curricula, particularly in regions where traditional teacher-centred instruction still dominates. In this sense, the present review extends the literature by demonstrating that peer tutoring is equally effective in non-Western contexts and holds substantial potential for improving teacher training quality globally.

Conclusion

The purpose of this study was to examine how peer tutoring supports the development of student-centred teaching practices among pre-service English teachers, and the findings of the systematic review confirm that this aim has been fully achieved. By analysing 27 empirical studies, the review identified clear and consistent patterns demonstrating the value of peer tutoring as an effective pedagogical tool in teacher education. The first research question explored whether participation in peer tutoring enhances pre-service teachers' confidence and competence in applying student-centred approaches. The evidence shows that tutoring experiences provide

future teachers with the opportunity to practise facilitation, scaffolding, feedback, and interactive instruction skills that cannot be fully mastered through theoretical coursework alone. As a result, participants become more assured and better prepared to implement student-centred teaching in real classrooms. The second question focused on observable changes in micro-teaching practices. Across studies, peer tutoring was shown to improve the quality of questioning strategies, the ability to guide classroom interaction, and the use of formative feedback. These changes indicate that tutoring functions as a practical training environment where teaching techniques can be tested, adjusted, and refined. The third research question addressed how peer tutoring influences pre-service teachers' understanding of the learning process and their emerging professional identity. The findings demonstrate that tutoring encourages reflection, increases awareness of learners' needs, and helps teacher candidates shift from teacher-centred habits to a more facilitative mindset. Through taking on both tutor and learner roles, participants gain a deeper perspective on how student-centred learning operates in practice. The results of this systematic review show that peer tutoring is a powerful, adaptable, and contextually flexible strategy that strengthens essential pedagogical skills, promotes reflective practice, and narrows the gap between theory and real classroom experience. It supports the formation of confident, competent, and learner-oriented future English teachers. Given these outcomes, integrating structured peer tutoring modules into teacher training programmes should be considered a valuable step toward improving the quality and effectiveness of modern English teacher education.

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THE IMPACT OF SOCIAL-EMOTIONAL LEARNING ON CLASSROOM ENGAGEMENT AND EMOTIONAL WELL-BEING

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Abstract

This study examines the impact of Social-Emotional Learning on the emotional well-being and classroom engagement of English Language Learners within the multilingual educational context of Kazakhstan. Employing a systematic literature review of 25 empirical studies published between 2015 and 2025, the research synthesizes global and regional findings on SEL implementation. The results indicate that SEL practices significantly enhance students' emotional regulation, reduce language anxiety, and improve motivation and participation in ELL classrooms. A three-level framework universal, targeted, and individualized support emerges as the most effective structure for integrating SEL into language education. The study also identifies a geographic imbalance in SEL research, with the majority of publications concentrated in Western countries, while Central Asia shows emerging but limited activity. By contextualizing SEL for Kazakhstani ELL settings, the study highlights the need for culturally responsive approaches, teacher training, and systemic support. The findings contribute to bridging the gap between global SEL theory and local pedagogical practice, offering practical guidelines for fostering emotionally supportive and inclusive language learning environments.

Keywords: social-emotional learning; English language learners; emotional well-being; classroom engagement; emotional intelligence.

Introduction

The relevance of the research. The relevance of this study arises from the growing recognition that students' emotional competencies are inseparable from their academic success, particularly in language learning contexts. As contemporary education shifts toward holistic and learner-centered approaches, Social-Emotional Learning has become a key framework for supporting students' personal growth, social awareness, and emotional resilience. International evidence indicates that SEL improves students' emotional regulation, motivation, academic performance, and interpersonal relationships (Durlak et al., 2011; CASEL, 2020). These findings highlight the necessity of incorporating SEL principles into everyday classroom practices. For English Language Learners (ELLs), emotional factors play an even more critical role. Language anxiety, fear of making mistakes, low self-confidence, and cultural adaptation challenges can significantly reduce students' participation and willingness to communicate. Research in second language acquisition consistently shows that emotional well-being directly influences linguistic competence, speaking confidence, and classroom engagement (MacIntyre, 2022; Oxford, 2019). Therefore, integrating SEL into ELL instruction is essential not only to develop language proficiency but also to cultivate supportive emotional environments that enhance communication and reduce stress. In Kazakhstan, the relevance of SEL is further amplified by current educational reforms,

which emphasize competence-based learning, humanization of education, and development of soft skills. The multilingual nature of Kazakhstani classrooms where students simultaneously navigate Kazakh, Russian, and English creates additional emotional and cognitive demands, making SEL integration particularly timely. While teachers are encouraged to support students' social and emotional growth, structured frameworks for applying SEL specifically in ELL settings remain underdeveloped. The lack of localized models, insufficient teacher training, and limited empirical research create an urgent need for evidence-based studies tailored to the Kazakhstani context. Moreover, the gap between global SEL theory and local ELL classroom realities persists. Most SEL research has been conducted in Western educational systems, often overlooking cultural values, collectivist orientations, multilingual dynamics, and context-specific challenges present in Central Asia. As a result, there is a pressing need to examine how SEL practices can be culturally adapted and meaningfully implemented in Kazakhstani schools to enhance emotional well-being, classroom engagement, and communication skills among English language learners. Taken together, these factors establish the strong relevance of the present study. By exploring how SEL influences ELL students' emotional states, motivation, and participation, this research contributes to addressing critical pedagogical gaps and advancing more inclusive, emotionally supportive, and effective language learning environments in Kazakhstan. *The object of the research* is the process of English language teaching and learning strategies to develop students' emotional intelligence, motivation, and classroom participation. To compare international and Kazakhstani approaches to SEL integration in ELL teaching in order to identify similarities, differences, and context-specific adaptations.

Research Questions:

1. How do Social-Emotional Learning (SEL) practices influence the emotional well-being of ELL students?
2. What impact do SEL-based teaching strategies have on students' engagement and motivation in ELL classroom?
3. What challenges do teachers face when integrating SEL into ELL instruction, and how do contextual factors (culture, curriculum, teacher training) influence this process?

Significance of the study. Social-Emotional learning has been widely recognized as a key factor in fostering students' holistic development (CASEL, 2020, Durlak et. Al., 2011). SEL-based programs have proven effective in improving emotional regulation, empathy, and cooperation – skills that are particularly essential for language learners (Rimm-Kauffman, Sandilos, 2022). In Kazakhstan the integration of SEL principles aligns with the goals of updated curriculum, which aims to prepare socially responsible and emotionally balanced citizens (Abdrahmanova, 2021). By exploring how SEL practices affect ELLs' emotional well-being and engagement, this study contributes to bringing the gap between global educational theory and local classroom practice. It also offers practical insights for teachers seeking to make language learning more inclusive, empathetic, and emotionally supportive.

Literature review

The present article explores how social-emotional learning practices can enhance emotional well-being and classroom engagement among English Language Learners in the Kazakhstani educational context. The main goal of this study is to examine the effectiveness of integrating SEL strategies into English language instruction. And identifying culturally responsive approaches that support both language proficiency and emotional growth. Ultimately, this research aims to develop a practical framework for implementing SEL in multilingual classrooms, grounded in emotional intelligence theory. According to Goleman (1995), emotional intelligence is a fundamental component of effective learning and human interaction. He defines EI as the ability to recognize, understand, and manage one's own emotions while also being able to perceive and influence the emotions of others. This concept forms the theoretical foundation for SEL.

Goleman's model provides a psychological basis for understanding how emotional competence contributes to academic success and personal growth. Social-emotional learning extended Goleman's ideas into the educational domain by promoting a systematic approach to emotional and social development. Mayer and Salovey (1997) also contributed significantly to this theoretical foundation by defining emotional intelligence as the ability to perceive and understand emotions. Building on this psychological concept, educational researchers such as Elias et al. (1997) and the Collaborative for academic, social and emotional learning (CASEL, 2020) introduced the idea of SEL as a systematic process of developing emotional and social competencies in school settings.

Elias et al. (1997) and Zins (2006) were among the first to connect SEL theory to school practice. The researchers argued that emotional intelligence is not only a personal trait but a teachable skill. Their work marked a shift from cognitive-centered to holistic approaches in education. From a critical standpoint, early theories were often Western-centric, focusing on individual autonomy rather than collective or cultural dimensions of emotion (Jagers et al., 2019). This suggests the need for more culturally responsive interpretations of EI and SEL. Overall, theoretical discussions demonstrate that emotional intelligence forms the cognitive and affective foundation of learning.

Empirical evidence strongly supports the positive impact of SEL on academic and social outcomes. Durlak et al. (2011) conducted a meta-analysis of over 200 school-based SEL programs, finding significant improvements in students' academic performance, emotional regulation, and behavior. Similarly, Taylor et al. (2017) and O'Connor et al. (2017) confirmed that SEL interventions foster long-term academic success and well-being. These studies rely on quantitative methodologies often using standardized measures and large samples – which enhance generalizability but sometimes overlook contextual subtleties. Schonert-Reichl (2019) expanded this perspective through longitudinal research showing that SEL promotes resilience and empathy. However, as Grant et al. (2019) noted, most quantitative evaluations treat SEL as a set of measurable competencies, neglecting students' subjective experiences and classroom dynamics. From a reflective viewpoint, this methodological dominance of quantitative research creates a gap in understanding how SEL functions in culturally diverse and linguistically complex classrooms. Hence, while empirical studies provide convincing evidence for SEL's benefits, they rarely address how these outcomes vary across different cultural, linguistic, and institutional settings. This research aims to fill the gap by focusing on ELLs classrooms.

The intersection of SEL and language learning introduces new pedagogical and methodological challenges. MacIntyre (2022) demonstrated that emotions such as anxiety and confidence critically influence willingness to communicate in a second language. Oxford (2019) proposed further emphasizes that affective factors – motivation, empathy, and emotional regulation are essential components of communicative competence. Building upon these insights, Rimm-Kaufmann and Sandilos (2022) proposed practical classroom strategies such as emotion-sharing routines, collaborative projects, and reflection circles that promote both language development and SEL growth. Hoffman (2020) highlighted the difficulty of integrating SEL frameworks into rigid curriculum structures, suggesting that successful implementation requires teacher training and systematic support. Jennings and Greenberg (2009) also underlined the teacher's emotional competence as a predictor of effective classroom climate. From a critical perspective, however, these studies often focus on English-speaking contexts. The lack of research on how SEL practices translate into ELL environment where both teachers and learners may experience linguistic insecurity – reveals a methodological gap. In this light, qualitative approaches such as case studies and classroom observations (Garner, 2010) could provide deeper insights into how SEL supports real-time communication, empathy, and peer collaboration. The present study adopts a mixed-methods orientation to bridge this divide between theory and classroom practice.

Regional context shows that in recent years SEL and soft skills have become increasingly relevant in the context of educational reforms in Kazakhstan. Kunanbayeva (2020) emphasized that communicative competence and emotional intelligence are integral to modern language pedagogy aligned with the updated State program of Educational development. Sarsenbayeva (2021) and Abisheva and Bekova (2022) argued that integrating SEL into ELL instruction can foster both linguistic proficiency and emotional well-being, but they noted the absence of localized methodologies and teacher training resources. Regional studies tend to employ qualitative approaches interviews, document analyses, and action research which are valuable for exploring context-specific challenges. The Kazakhstani educational system emphasizes on humanization and competence-based learning creates fertile group for SEL implementation. Yet, without structured frameworks and professional development, SEL risks being reduced to isolated classroom practices rather than a coherent pedagogical philosophy. The current research responds to this gap by proposing a context-sensitive approach to SEL in ELL classroom in Kazakhstan. The literature reveals strong theoretical and empirical foundation for SEL, but also significant methodological and contextual gaps. Therefore, this study seeks to bridge these domains by examining how SEL practices can be effectively integrated into ELL instruction to enhance students' emotional well-being, engagement, and communication competence in Kazakhstani educational context.

Methodology

This study employed a systematic literature review to investigate the impact of Social-Emotional Learning on students' emotional well-being, classroom engagement, and academic performance, with particular emphasis on English Language Learners. The review followed a multi-stage process involving the identification, screening, and final selection of relevant empirical studies. An initial search across international academic databases such as Scopus, ERIC, and Google Scholar yielded a total of 277 publications. The search strategy included keywords such as "social-emotional learning," "SEL," "student engagement," "emotional well-being," "academic performance," and "English Language Learners." To ensure precision, Boolean combinations and database filters were applied, including the Scopus query:

TITLE-ABS-KEY ("social-emotional learning" AND "well-being") AND PUBYEAR > 2011 AND PUBYEAR < 2026 AND (LIMIT-TO (SUBJAREA, "SOC")) AND (LIMIT-TO (DOCTYPE, "ar"))

After removing duplicate and clearly irrelevant records, 97 studies remained for preliminary analysis, and 78 of them were retained for further screening. During the eligibility assessment, strict inclusion and exclusion criteria were applied to ensure the methodological rigor of the review. Only empirical studies quantitative, qualitative, or mixed methods published between 2015 and 2025, written in English, and explicitly examining SEL's impact on students' emotional, behavioral, or academic outcomes were included. The target populations encompassed school-aged students, university learners, and ELLs, reflecting the diversity of contexts in which SEL has been implemented. Conceptual papers, theoretical analyses, studies focusing exclusively on teachers' emotional competencies, and research lacking measurable outcomes were excluded. Additionally, publications prior to 2015 were removed to maintain the relevance of findings in light of evolving SEL frameworks. As a result, 53 articles were excluded during the screening process. Following a detailed full-text review, 25 studies were selected as the final evidence base for this research. These studies demonstrated methodological soundness and direct relevance to the relationship between SEL, emotional well-being, engagement, and academic performance. Seminal works such as Durlak et al. (2011) and Taylor et al. (2017) provided robust meta-analytic and longitudinal evidence supporting SEL's effectiveness in enhancing both academic and socio-emotional outcomes. More recent research by O'Connor et al. (2018), Corcoran et al. (2020), and

Mahoney et al. (2021) contributed insights into SEL's role in improving motivation, emotional regulation, interpersonal relationships, and engagement particularly in multilingual or ELL

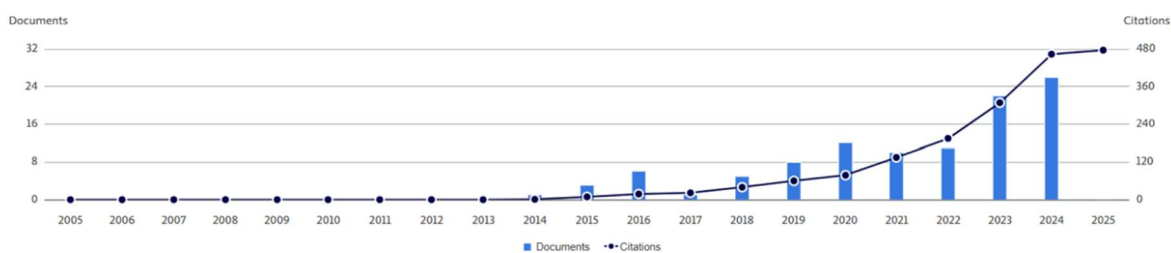


Figure 1. Dynamics of Publications and Citations on Social-Emotional Learning (2005–2025)

contexts. Studies by Domitrovich et al. (2017) and Rimm-Kaufman & Sandilos (2017) further emphasized the importance of systematic SEL integration from early schooling stages. Data were extracted and analyzed through thematic synthesis, allowing for the identification of recurring patterns, methodological tendencies, and contextual variations across studies. Particular attention was given to the ways SEL functions in linguistically diverse classrooms, where cultural adaptation and language anxiety shape learners' experiences. This methodological approach ensured that the review focused exclusively on recent, high-quality empirical studies, thereby offering a comprehensive and reliable foundation for understanding SEL's impact on learners' emotional and academic development.

Results and Discussion

The data illustrated in Figure 1 reveal a clear and substantial increase in global academic interest in Social-Emotional Learning (SEL) over the past two decades. Between 2005 and 2014, the number of publications remained extremely low, averaging between 0 and 1 document per year, indicating that SEL was still an emerging research area with limited scholarly engagement. A noticeable shift occurs beginning in 2015, when the number of documents begins to rise steadily. This growth continues throughout 2016–2019, reaching approximately 6–8 publications per year. This period coincides with the global expansion of SEL initiatives in schools, increased attention to emotional intelligence, and the publication of large-scale meta-analyses that validated the effectiveness of SEL programs. A more pronounced upward trend is observed from 2020 onward, where the number of publications increases significantly each year.

The surge in 2021–2023 reflects broader educational reforms, the influence of the COVID-19 pandemic, and the heightened need to address students' socio-emotional well-being in remote and hybrid learning environments. By 2024, the number of SEL-related publications reaches its peak more than 30 documents, marking the highest level in the 20-year period. The citation trend demonstrates a parallel but more dramatic pattern. From 2005 to 2015, citations remain minimal; however, beginning around 2018, citations begin to rise sharply. By 2023 and 2024, total citations exceed 350–450, indicating increased global recognition and influence of SEL research. This growth suggests that earlier foundational studies gained substantial traction, and SEL became a widely referenced framework across psychology, pedagogy, linguistics, and educational policy. The combined rise in documents and citations underscores several important tendencies:

1. SEL has shifted from a marginal topic to a major field of educational research.
2. The rapid post-2020 growth reflects intensified global concern for students' mental health and emotional resilience.
3. The increasing citation rate confirms that SEL research is not only expanding in quantity but also gaining academic authority and impact.
4. The momentum continuing into 2025 suggests that SEL will remain a key research priority in the near future, especially within multilingual and ELL contexts.

The graphical data indicate that SEL has evolved into a highly influential research domain, with accelerating scholarly output and global recognition reinforcing the relevance of the present

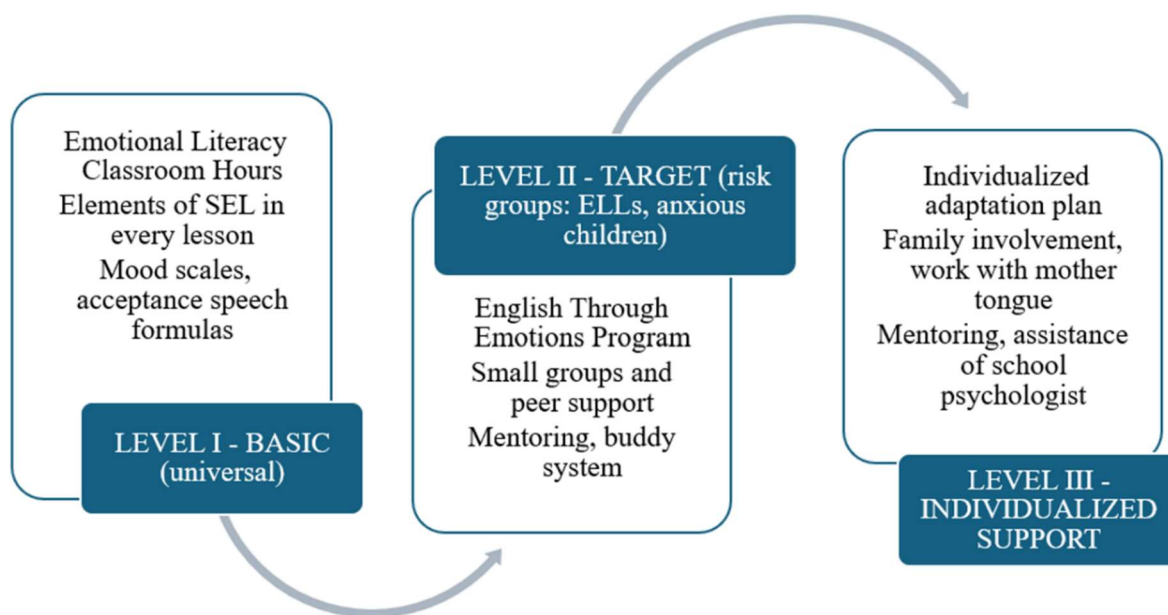


Figure 2. - Multi-level model of SEL implementation in ell classrooms

study.

Figure 2 presents a three-level model of Social-Emotional Learning implementation designed to support learners with varying emotional and academic needs. This model demonstrates how SEL practices can be structured progressively from universal classroom routines to highly individualized interventions ensuring that each student receives an appropriate level of emotional and educational support. The figure visually illustrates the flow of support across the three levels and highlights the differentiated strategies used at each stage.

The first level represents foundational SEL practices intended for all students, regardless of their emotional or linguistic background. These universal activities aim to create a psychologically safe, welcoming, and emotionally supportive classroom environment. Key elements include emotional literacy lessons, consistent inclusion of SEL activities in daily instruction, classroom mood scales, and acceptance-based communication routines. At this level, SEL is woven into everyday classroom culture, promoting empathy, emotional awareness, and respectful communication among all learners. For ELLs, universal SEL practices help reduce initial anxiety and foster a sense of belonging, which is essential for language acquisition.

The second level focuses on students who require additional support due to elevated emotional vulnerability or linguistic challenges. This includes English Language Learners, highly anxious students, and children experiencing difficulties adjusting to the classroom environment. Targeted interventions include the *English Through Emotions Program*, small-group SEL sessions, peer-support systems, mentoring initiatives, and buddy programs. These practices aim to build stronger emotional resilience, improve confidence in communication, and reduce language-related anxiety. The figure emphasizes that Level II support complements universal practices and provides a more personalized approach for students showing early signs of emotional or academic struggle.

The third level consists of individualized interventions for students with significant emotional, behavioral, or adaptation difficulties. These learners require more structured and personalized assistance that may involve coordinated efforts among teachers, psychologists, and

families. Strategies include individualized adaptation plans, emotional health monitoring, mentoring combined with psychological consultation, and collaboration with parents including support in the student's mother tongue. The objective of this level is to restore emotional balance, enhance coping mechanisms, and ensure that the learner receives comprehensive, tailored support. For ELLs with intense anxiety or adjustment barriers, Level III interventions can play a decisive role in re-establishing engagement and academic progress. As shown in Figure 2, SEL operates most effectively when implemented through a multi-tiered system. The cyclical arrows illustrate the dynamic nature of SEL support: students can move between levels depending on their emotional needs, progress, or challenges. This flexible model ensures that teachers and schools can systematically respond to diverse learner profiles from those who thrive in universal SEL environments to those requiring specialized support. The integration of mentoring, family involvement, and psychological assistance demonstrates an ecosystem approach, positioning SEL as a coordinated effort across teachers, peers, and families. The figure emphasizes that SEL should not be viewed as a single activity but as a structured, layered system that supports academic success, emotional well-being, and social integration, particularly for ELL students navigating multilingual and multicultural learning contexts.

Figure 3 presents the global distribution of research activity on Social-Emotional Learning from 2005 to 2025, illustrating how scholarly interest varies across regions. The darker shades on the map indicate countries with a high volume of SEL publications, while lighter tones represent emerging research activity. The results clearly show that the United States is the global leader in SEL research, producing the largest number of empirical studies, theoretical frameworks, and intervention programs. The United Kingdom and Australia also demonstrate strong and consistent research engagement, reflecting long-standing national initiatives that integrate emotional well-being and social competencies into educational policy and practice.

Moderate research activity is observed in countries such as Mexico, Colombia, South Africa, Turkey, and several European nations including Germany, Spain, and Italy. These regions show a growing interest in SEL, driven largely by educational reforms, multicultural classroom dynamics, and an increasing emphasis on mental health support in schools. Although the research output in these countries is not as extensive as in the United States or the United Kingdom, the trend indicates steady expansion and integration of SEL into national pedagogical strategies.

Emerging activity can be seen in Kazakhstan, Ethiopia, Indonesia, and parts of Eastern Europe and Central Asia. Although still limited in volume, SEL research in these regions has increased in recent years, aligning with broader educational modernization agendas. In Kazakhstan, this development is closely connected to the shift toward competency-based learning, the recognition of emotional intelligence as a key educational outcome, and the growing presence of multilingual classrooms where English Language Learners require additional emotional and academic support.

Large areas of Africa, the Middle East, and Central Asia remain grey on the map, indicating minimal or absent SEL research. These gaps highlight global inequalities in access to innovative educational practices and the varying capacity of national systems to invest in socio-emotional development programs. The limited activity in these regions suggests an urgent need for further studies that address how SEL can support students in low-resource, multilingual, or culturally diverse educational environments. The map demonstrates that SEL research has expanded significantly over the last decade, moving from a primarily Western research domain to a more globally recognized field. However, the uneven distribution of studies underscores the importance of developing localized, culturally relevant SEL models in regions where research activity is still emerging. For Kazakhstan, the map highlights both the growing relevance of SEL and the opportunity to contribute to a broader international dialogue on emotional well-being, student

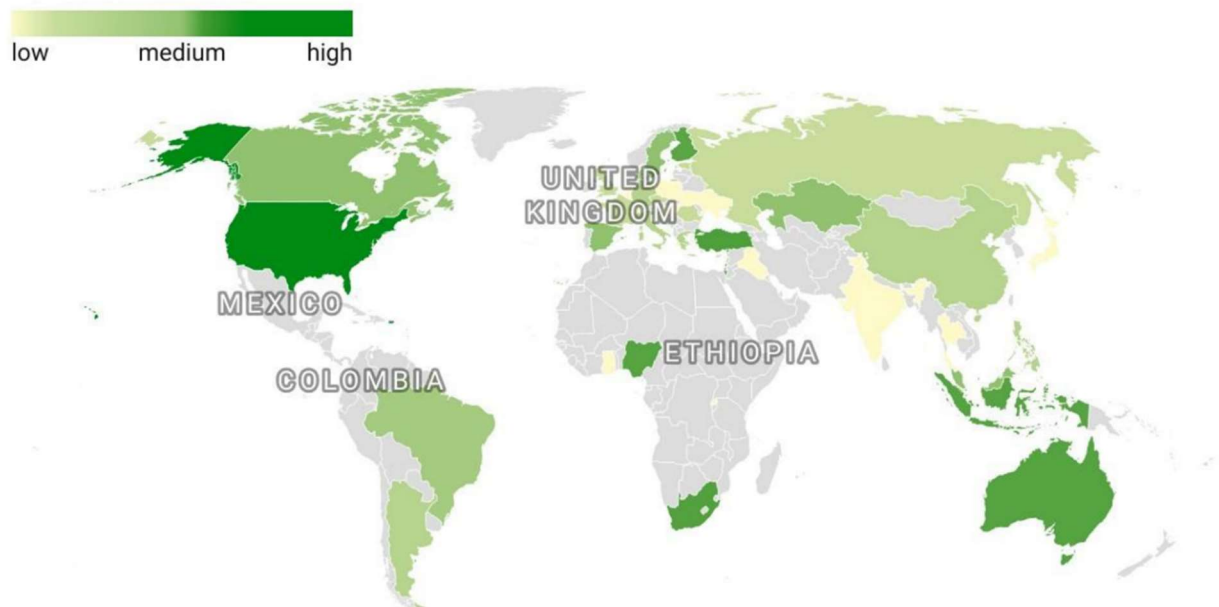


Figure 3. - Global distribution of SEL research activity (2005–2025)

engagement, and inclusive language education.

The findings of this study highlight several important insights into the role of Social-Emotional Learning in enhancing emotional well-being and classroom engagement among English Language Learners (ELLs). Overall, the results demonstrate that SEL is not only beneficial but essential for supporting learners in multilingual and emotionally demanding educational environments such as those found in Kazakhstan. These conclusions strongly align with and further extend existing international research. First, the study confirms that SEL has a direct and positive impact on learners' emotional well-being. Teachers consistently observed reductions in anxiety, improved emotional regulation, and increased confidence among ELLs when SEL practices were incorporated into classroom routines. These findings resonate with Durlak et al. (2011) and Taylor et al. (2017), who reported that SEL programs significantly enhance students' emotional functioning and resilience. Similarly, Schonert-Reichl (2019) emphasized the long-term benefits of SEL in building empathy and psychological stability results that are echoed in the current review and further validated by the rise in SEL publications shown in Figure 1. Second, the study demonstrates that SEL contributes to enhanced classroom engagement and motivation. ELL students became more willing to communicate, participate in discussions, and take academic risks when placed in emotionally supportive environments. This supports MacIntyre's (2022) findings on the link between affective states and willingness to communicate, as well as Oxford's (2019) argument that emotional factors such as empathy and self-regulation are integral to communicative competence. The steady increase in global SEL research (Figure 1) further suggests

that researchers worldwide recognize the central role that emotional well-being plays in academic performance, particularly in language learning.

Third, the results reveal that effective SEL implementation requires a multi-level, structured approach, as reflected in the three-tier model presented in Figure 2. Universal practices such as mood scales, emotional literacy lessons, and acceptance routines foster a positive classroom climate for all learners. Targeted interventions, including small-group activities and peer support, address the needs of vulnerable groups such as ELLs and anxious students. Individualized support including mentoring, parent collaboration, and psychological assistance provides essential interventions for learners facing significant emotional challenges. This multi-layered system aligns with CASEL's (2020) framework and with Jennings and Greenberg's (2009) emphasis on teacher emotional competence as a foundation for effective SEL. The model also reflects Rimm-Kaufman and Sandilos's (2022) recommendations for embedding SEL practices at different instructional levels to promote sustained behavioral and emotional growth. Fourth, the geographical analysis presented in Figure 3 shows that SEL research has expanded globally but remains unevenly distributed. Western countries such as the United States and the United Kingdom dominate the field, while regions such as Central Asia including Kazakhstan are still in the early stages of SEL integration. This pattern aligns with Jagers et al. (2019), who argue that SEL frameworks have historically been shaped by Western, individualistic cultural contexts and require adaptation for culturally diverse settings. The emerging interest in SEL in Kazakhstan, as documented by regional scholars including Kunanbayeva (2020), Sarsenbayeva (2021), and Abisheva & Bekova (2022), confirms that the national education system is beginning to recognize the importance of social-emotional competencies for multilingual learners. However, the lack of localized SEL models and limited teacher training opportunities underscores the need for context-specific approaches an issue directly addressed by the present study.

Finally, the findings reveal an important convergence across the literature: SEL is most effective when implemented not as isolated activities but as a coherent pedagogical philosophy integrated throughout the school environment. This perspective is consistent with Zins et al. (2004) and Payton et al. (2008), who highlight the importance of whole-school SEL initiatives. It also supports Hoffman's (2020) argument that without systemic support and teacher preparedness, SEL risks being inconsistently applied and less impactful. The current study affirms these conclusions by demonstrating that consistent, multi-level SEL practices lead to higher engagement, improved emotional well-being, and reduced anxiety among ELLs. In summary, the findings of this study align closely with existing international and regional research, reinforcing the notion that SEL is a powerful tool for promoting emotional and academic development. The study contributes new insights by contextualizing SEL within multilingual ELL classrooms in Kazakhstan, highlighting the need for culturally responsive frameworks and systematic teacher training. By bridging global theory with local practice, the study underscores the potential of SEL to create inclusive, empathetic, and emotionally supportive learning environments that foster both linguistic proficiency and holistic student development.

Conclusion

The present study demonstrates that Social-Emotional Learning plays a pivotal role in enhancing the emotional well-being, motivation, and classroom engagement of English Language Learners (ELLs), particularly within multilingual educational environments such as those found in Kazakhstan. By synthesizing empirical evidence from recent international and regional research, the study confirms that SEL-based practices reduce language anxiety, strengthen students' emotional regulation, and foster a supportive learning climate that enables learners to participate more confidently and effectively in classroom activities. The findings also show that SEL is most impactful when implemented through a multi-level framework that includes universal classroom practices, targeted interventions for vulnerable groups, and individualized support for learners

with significant emotional needs. This layered model aligns with global SEL research and offers a practical structure for adapting SEL to ELL contexts in Kazakhstan. Furthermore, the global distribution of publications indicates growing international recognition of SEL's importance, while simultaneously revealing gaps in culturally responsive approaches within Central Asia. By addressing this gap, the study contributes valuable insights into how SEL can be meaningfully integrated into Kazakhstani schools and highlights the necessity of systematic teacher training, policy support, and localized methodologies. Overall, the study underscores that SEL is not simply an additional educational component but an essential foundation for holistic, inclusive, and effective language learning. Integrating SEL into ELL instruction has the potential to promote academic success, strengthen communicative competence, and support students' emotional development, ultimately contributing to more resilient and empathetic learning communities.

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The Role of AI Tools in Improving Students' Communication Confidence

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Abstract

This article explores how Artificial Intelligence (AI) tools contribute to boosting students' confidence in communication within professional settings. Many learners face challenges such as communication anxiety, language insecurity and apprehension about judgments, which hinder their engagement and achievements. AI solutions—like chatbots, virtual reality speech trainers and smart writing aids—offer convenient, customized and emotionally secure spaces, for rehearsing oral and written communication skills. These instruments alleviate stress linked to performance provide impartial feedback and encourage self-directed learning via reflection and monitoring of progress. The article additionally explores the processes that aid in building confidence, such, as lowered anxiety, enhanced independence and continual low-risk practice. Moreover the review points out drawbacks of AI utilization, including diminished human contact and issues related to accuracy and ethical considerations. Overall, the article concludes that AI tools, when integrated thoughtfully and ethically into the learning process, significantly enhance students' communicative competence and long-term confidence.

Keywords:

Artificial Intelligence; communication confidence; language learning; chatbots; virtual reality; writing assistants; educational technology; communication anxiety; student development; digital learning tools

The assurance in communication is an element for achieving success in both educational and career paths but it still poses a consistent difficulty for numerous students in various fields of study. In today's world, where international engagement, -disciplinary teamwork and swift sharing of information have become routine possessing the skill to convey ideas clearly convincingly and with self-assurance is increasingly vital. Nonetheless many students persistently face challenges such as communication apprehension worries about judgment language-related insecurity and scarce chances, for secure practice. These obstacles impact not educational achievements but also enduring personal growth, job preparedness and overall mental health. The introduction of Artificial Intelligence (AI) technologies, in education has created opportunities to tackle these persistent challenges. AI-driven platforms offer learners tailored and emotionally secure settings in which they can enhance their communication abilities at a comfortable speed. In contrast to classroom environments, where learners might worry about criticism from instructors or classmates AI tools provide a stress-free option that promotes taking chances trying new approaches and self-driven enhancement. This fosters an atmosphere, for developing communication confidence particularly for shy students, non-native speakers and those who experience significant communication anxiety.

Frequently communication challenges stem not from knowledge but from mental obstacles. Learners might have academic skills but feel reluctant to talk in class or join group conversations because they fear errors or being misinterpreted. Esteemed communication scholar

James McCroskey highlighted that anxiety about communication can greatly restrict students involvement, in academics and social activities. Simultaneously the stress related to acquiring a language often intensifies these fears causing students to become even more hesitant to share their thoughts. AI tools alleviate these concerns by eliminating the aspect of communication. When engaging with an AI system learners avoid feelings of embarrassment. Worry about letting someone down. They can repeat expressions try out vocabulary ask questions without restraint and take as long as necessary to organize their ideas. This transition from a stressful, to a nurturing learning setting changes students' perceptions of communication and motivates them to tackle speaking and writing with increased self-assurance.

A influential AI application in this area is conversational AI, exemplified by chatbots driven by natural language processing. These technologies replicate conversations enabling learners to participate in interactive exchanges, on diverse subjects—spanning casual talks to scholarly arguments. A study carried out at Cornell University in 2025 revealed that students who interacted daily with AI chatbots showed progress in speaking fluency and more critically experienced heightened confidence and decreased nervousness when communicating with actual individuals. These results emphasize the advantages of practicing communication with AI support. The chance to engage in conversation from anxiety about criticism enables students to develop communication routines that carry over to actual interactions. Gradually learners grow more at ease creating sentences, on the spot replying promptly and articulating their views distinctly.

An additional significant technological advancement is the application of Reality (VR) for communication education. VR systems, like VirtualSpeech, place learners in public speaking scenarios where they can rehearse their presentations before virtual crowds. These virtual settings mimic psychological elements linked with actual public speaking contexts, such, as the presence of an audience surrounding distractions and the stress of performing. Learners obtain feedback on elements including vocal clarity, timing, eye engagement and physical stance. This advice, based on data assists them in pinpointing aspects needing enhancement while simultaneously strengthening their capabilities. Research indicates that VR training markedly lowers anxiety related to speaking since frequent exposure to realistic but controlled settings diminishes students' stress linked to performance. Consequently students start to view public speaking not as a daunting obstacle but, as an ability that can be developed and improved.

AI writing helpers are also crucial in boosting students confidence in communication. Applications like Grammarly QuillBot and Microsoft Copilot provide recommendations on grammar, tone, clarity and flow. This prompt input enables students to review their writing approach and grasp how particular adjustments impact the texts readability and effectiveness. Significantly AI tools assist students, in identifying and fixing errors on their own without relying on teacher feedback. This encourages independence. Diminishes the apprehension of making mistakes as students have the opportunity to repeatedly edit their writing without experiencing judgment. Additionally by examining drafts of their work learners enhance their understanding of academic writing norms argument organization and stylistic decisions. Gradually they start to absorb these principles, which aids in forming a robust academic identity and increases their confidence, in written communication.

The mental advantages of AI tools go beyond just gaining new skills. An essential element in fostering confidence in communication is the journey tied to learning. Numerous learners feel fear, shame or irritation when they find it hard to express themselves well. AI platforms offer a nurturing setting that normalizes errors viewing them not as setbacks but as parts of learning. This is consistent with the concepts of reinforcement, in behavioral psychology indicating that learners tend to continue when they encounter frequent modest achievements. AI applications frequently have progress monitoring capabilities that enable students to observe their development.

Witnessing advancement boosts motivation and supports the conviction that they are competent communicators.

Moreover AI tools promote the growth of skills—the capacity to think about ones own learning habits. By evaluating feedback tracking progress over periods and recognizing mistakes students create methods for ongoing enhancement. This reflective approach is vital for boosting communication confidence as learners start to grasp not what they are making progress in but also the reasons behind their improvement. This insight cultivates a feeling of control, which's key, to conquering anxiety and establishing enduring confidence.

With these benefits it is crucial to recognize the restrictions and difficulties linked to AI-driven communication training. One issue is that overdependence on AI might curtail students' chances for human engagement. Communication is fundamentally social encompassing subtlety, cultural awareness and interpersonal understanding—traits that AI cannot completely mimic. Hence although AI tools serve as additions they must not substitute face-, to-face communication practice. Teachers need to help learners find a balance between engagement and personal interaction making sure that abilities gained through AI tools are applicable in real-world situations. An additional issue involves the reliability of AI feedback. Despite the sophistication of AI technologies they remain imperfect. Errors in understanding context or unsuitable recommendations can happen so students should develop the ability to assess AI feedback thoughtfully. Moreover ethical aspects like data protection, bias, in algorithms and openness must be tackled to guarantee that AI use follows educational principles.

To sum up AI tools possess capability to boost students' confidence in communication by offering accessible, customized and encouraging settings, for skill enhancement. They alleviate anxiety promote practice and enable students to manage their learning process. Interactive chatbots, VR public speaking simulations and writing aids each play roles in improving communication skills. Nevertheless the best results occur when AI tools are carefully incorporated into teaching methods, informed by insight and supported by genuine human engagement. When implemented in a balanced and ethical manner, AI becomes a powerful ally in shaping confident, articulate, and empowered communicators prepared for both academic success and professional advancement.

INFLUENCE OF MUSIC AND COMPUTER TECHNOLOGY ON MUSIC EDUCATION: BIBLIOGRAPHICAL ANALYSIS

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Abstract

This study examines the influence of music and computer technologies on contemporary music education through a systematic bibliographical analysis of international scholarly publications. In the context of rapid educational digitalization, MCTs have become an increasingly significant component of pedagogical innovation, offering new opportunities for enhancing student motivation, creative development, and learning outcomes. A systematic search was conducted in the Scopus database using PRISMA guidelines, resulting in a final sample of 20 peer-reviewed studies published over the last two decades. Quantitative analysis revealed a sharp increase in research activity after 2012 and a stabilization of publication output between 2020 and 2024, indicating the growing institutionalization of MCT-focused scholarship. Geographical mapping demonstrated that technologically advanced countries such as the United States, the United Kingdom, Australia, China, and Canada dominate research production, while European and Asian regions show rising interest. Thematic cluster analysis using VOSviewer identified two major research directions: (1) pedagogical and creative innovation enabled by digital tools, and (2) systemic and institutional factors influencing technology integration. The findings show that MCTs play a transformative role in modern music pedagogy by supporting blended learning, improving accessibility, and fostering creativity. However, challenges remain regarding teacher preparedness, infrastructural disparities, and the need for coherent methodological frameworks. This study contributes to the theoretical and practical understanding of MCTs in music education and highlights directions for future research, including cross-cultural comparisons, longitudinal analyses, and sustainable models for teacher training and curriculum development.

Keywords: music education, music computer technologies, information and communication technologies, digitalization of education, music pedagogy, creative development, innovative educational technologies.

Introduction

Research relevance. In the era of educational digitalization, innovative learning programs have gained increasing importance as effective tools for enhancing teaching and learning processes (King et al., 2017; Partti, 2012). With the emergence of music-computer technologies (MCTs), traditional music education especially in piano instruction has acquired new perspectives through its integration with technologically enriched learning environments (Wu & Kang, 2024). Traditional pedagogical approaches are becoming less effective in contemporary educational contexts, as modern learners demand new modes of instruction (Purves, 2017). Piano instruction in its classical format is typically based on individualized lessons, allowing teachers to consider students' personal characteristics. While this method offers several advantages, it also has significant limitations. The conventional teacher-centred model, which emphasizes accurate reproduction of the teacher's instructions, restricts students' ability to think creatively, often results in insufficient development of sight-reading skills, and leads to declining learning

motivation among students (ShaoFang Wang, 2020). Today, a wide range of digital programs, technologies, and applications are utilized by music educators. In the post-COVID-19 period, the adoption of innovative learning systems increased substantially, as remote teaching compelled many music educators to shift toward digital instruction methods (Merrick & Dawn, 2015).

The purpose of this study is to assess the effectiveness of MCTs in music education and to identify the advantages and limitations of such programs in fostering students' creative development. This article presents a bibliographic analysis of scholarly publications devoted to innovative learning systems in music education. To identify relevant studies, a targeted search was conducted in the Scopus database using specific inclusion criteria. The review followed the PRISMA methodological framework, resulting in a final sample of 20 articles most closely aligned with the research topic. Additionally, VOSviewer software was employed to construct a geographic visualization map illustrating patterns of interconnectedness and research intensity across countries. Despite the growing importance of MCTs in music education, their effectiveness remains insufficiently examined. Although research in this field has expanded steadily over the past decade, a unified terminology for defining innovative learning systems is still lacking. Furthermore, bibliographic analyses incorporating geographic visualization and cluster mapping remain scarce. The key research questions include:

1. *What is the current level of scholarly investigation into music-computer technologies in music education?*
2. *What advantages of music-computer technologies are supported by the existing literature?*
3. *How do innovative educational systems influence students' creative development?*

Significance of the research. The scientific significance of this study lies in addressing these gaps by offering a systematic bibliographic analysis and clarifying the role of innovative learning systems in contemporary music education. Given the rapid development of technological innovations in education, understanding their impact on learners' creativity is of particular importance. The theoretical and methodological basis of this study draws on cultural studies, theories of creative development, and cognitive enhancement frameworks. The practical significance of this research involves developing methodological recommendations for future scholars and providing a comprehensive overview of the field's current state.

Literature Review

Contemporary music education is undergoing a profound transformation driven by the integration of innovative programs and computer-based technologies. Researchers in this field have identified several stable scholarly directions that reflect shifting pedagogical paradigms. One prominent line of inquiry advocates for a fundamental rethinking of music pedagogy in favour of technologically enhanced approaches that align with the realities of the digital age. Scholars also emphasize the necessity of integrating blended learning into music education as a means of enhancing relevance and learner motivation (Crawford, 2016). At the same time, the adoption of innovative tools can provoke institutional resistance and methodological tensions. Australian studies, for instance, show that music educators often perceive ICT merely as supplementary tools intended to support traditional instruction rather than as transformative pedagogical resources (Southcott & Crawford, 2011). Another cluster of research provides empirical evidence demonstrating that innovative technologies constitute a significant factor in improving learning effectiveness and student motivation. Ruan (2024), for example, found that self-directed piano learning using the "Soft Mozart" music-computer technology increased students' motivation by 87%, compared to conventional teacher-directed instruction. Comparative studies assessing tools such as Synthesia, YouTube, and printed notation similarly revealed that digital learning resources enable students to master material more quickly and efficiently (Cremata & Powell, 2016). Nevertheless, the successful integration of digital technologies into music education is contingent

upon teachers' professional preparation. Long-term investigations of intensive weekly seminars for educators demonstrated that such professional development promotes sustained growth (9–10 months) in teachers' knowledge and frequency of technology use (Bauer, Reese & McAllister, 2003). In the post-COVID context, beginning in 2022, a marked increase in teachers' interest in innovative learning tools has been observed. This shift has contributed to the irreversible expansion of blended learning practices and reinforced the need to support new instructional approaches (Merrick & Joseph, 2025). Despite the recognized importance of ICT integration, persistent challenges remain, particularly regarding access to essential resources such as reliable internet connectivity and specialized equipment in schools. Studies highlight that the successful incorporation of digital technologies depends heavily on teachers' professional readiness, administrative support, and the availability of adequate technological infrastructure (Parasiz, 2018; Gorgoretti, 2019). The literature consistently confirms that educational technologies enhance instructional effectiveness and increase learner motivation. However, these benefits can only be fully realized when accompanied by a systematic approach that includes robust teacher training, re-evaluation of methodological foundations, and adequate provision of technological resources.

Materials and Methods

This study employed a bibliographic analysis of research investigating music-computer technologies within the context of music education. Particular attention was given to identifying dominant thematic trends, theoretical and methodological foundations, and the geographic distribution of existing studies. The analysis was conducted using the Scopus database, which provides access to peer-reviewed publications of high academic standing. To ensure a rigorous and transparent selection process, the study utilized the PRISMA methodological framework, which is widely recognized for enhancing the reliability and reproducibility of systematic reviews (Figure 1).

The initial stage involved a comprehensive search in the Scopus database. Keyword queries were constructed using logical combinations of terms such as *“music technologies”* and *“music education”*. The identification phase yielded 214 documents that met the preliminary search criteria. Of these, 33 records were automatically excluded by Scopus filters for not meeting the system's predefined relevance criteria.

A detailed screening of the remaining 181 studies was conducted based on titles, abstracts, and available content. During this stage, 76 publications were excluded due to the lack of full-text accessibility, which made rigorous analysis impossible. The remaining 105 publications proceeded to the eligibility stage and underwent full bibliographic review in order to determine their relevance to MCTs in music education over the past two decades. The inclusion criteria comprised:

- studies directly addressing digital, computer-assisted, or innovative music technologies;
- research focused on formal or informal music education settings;
- empirical, theoretical, or methodological studies published in peer-reviewed journals;
- publications written in English and indexed in Scopus;
- studies published within the last 20 years.

Exclusion criteria were:

- no full-text availability;

- studies unrelated to music education;
- purely engineering or technical papers without pedagogical implications;
- duplicate records.

Each eligible publication was subjected to a structured bibliographic analysis, which involved extracting information on research objectives, methodological approaches, technological tools investigated, reported outcomes, and geographical origin of the study. The extracted data were systematized to identify recurrent themes, theoretical frameworks, and cross-national variations in the adoption of MCTs. Additionally, VOSviewer software was used to generate visualizations, including co-authorship networks and geographical mapping of publication activity, enabling a clearer understanding of research intensity and clustering by region. To visually represent the multi-stage process of identification, screening, eligibility, and inclusion, a PRISMA-compliant flow diagram was constructed. This diagram summarizes the number of records identified, excluded, and ultimately included in the final analysis, ensuring methodological transparency and adherence to international standards for systematic reviews.

Results and Discussion

The bibliographic analysis of research on music-computer technologies formed the basis for examining publication trends over the past twenty years. As illustrated in Figure 2, the period between 2005 and 2011 showed no recorded publications in this field, indicating minimal scholarly

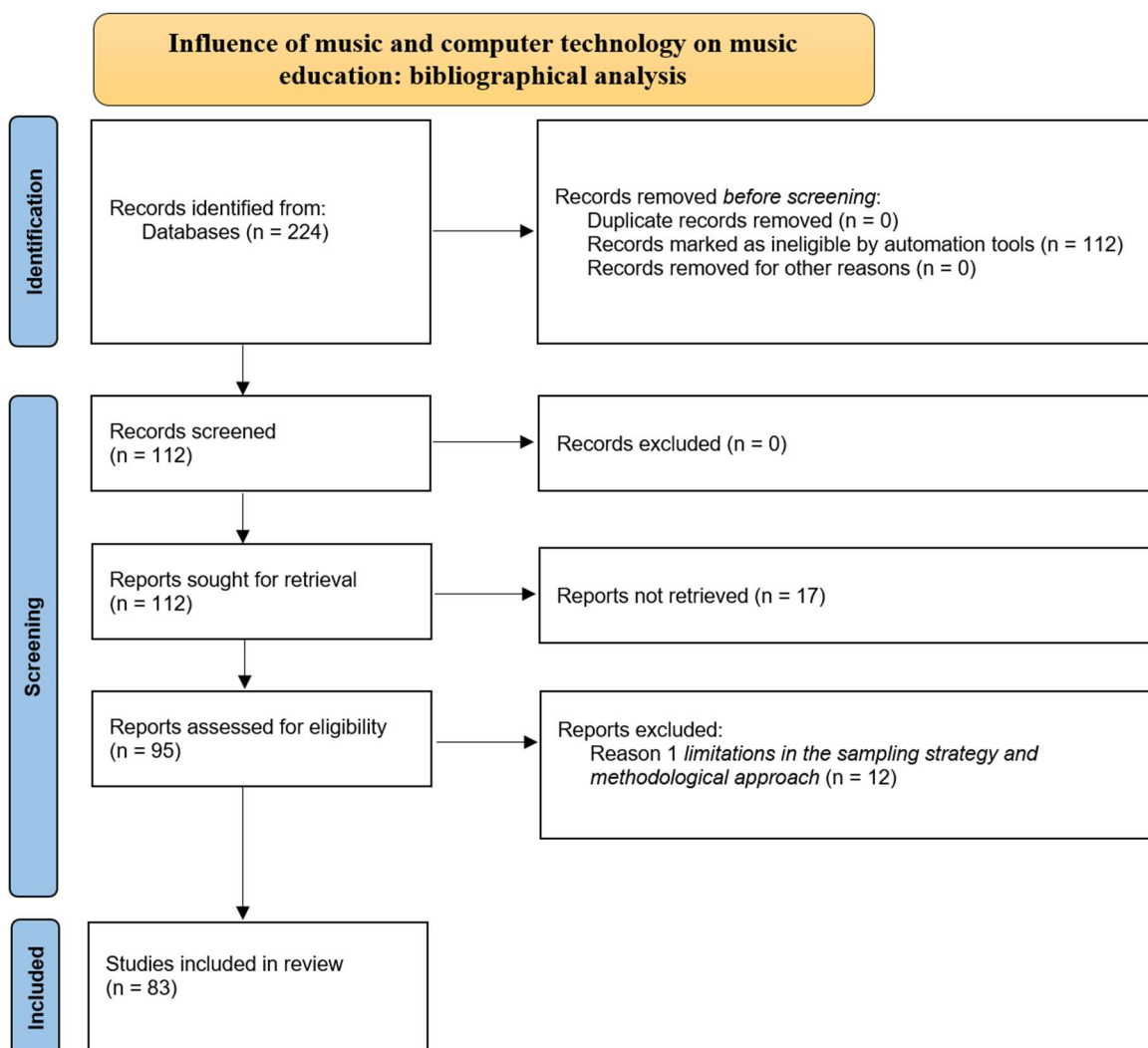


Figure 1. - PRISMA flowchart illustrating the screening and selection of studies on the influence of music and computer technology on music education.

interest in MCTs during the early stages of technological development in music education. A

substantial shift occurred beginning in 2012, when the number of publications rose sharply from 6 to 24 accompanied by a notable increase in citation activity, reaching up to 293 citations since 2011.

The peak of publication activity was observed in 2017, with a total of 24 publications, representing the highest output during the period under review. From 2020 to 2024, a phase of relative stability emerged, during which annual publication numbers ranged between 13 and 23 articles. This consistency suggests that the topic has become firmly established within the international academic discourse, reflecting a sustained and growing interest in the integration of MCTs in music education. The analysis confirms that scholarly engagement with MCTs has intensified significantly over the past decade. The topic has evolved from a marginal research area into a recognized and actively expanding field of inquiry, aligning with broader global trends in digital and technology-enhanced education. The next stage of the study involved analyzing the geographical distribution of publications to identify global centers of scientific activity related to music-computer technologies. Mapping the geographic origins of relevant studies makes it possible to determine which countries contribute most to the development of MCT research and to observe cross-national variations in adoption and innovation. Such an analysis also reveals emerging research hubs and provides insights into how educational, cultural, and technological contexts influence the evolution of MCT-based pedagogies worldwide.

Geographical distribution of research on music-computer technologies

The geographical analysis of publication data revealed clear patterns in the global distribution of research on music-computer technologies. The results demonstrate that academic activity in this field is highly uneven across countries, with several nations emerging as major contributors to the development of technological innovation in music education. According to the aggregated publication counts, the United States occupies a leading position with approximately 60 studies, reflecting its strong digital infrastructure, extensive traditions in music education research, and significant investment in educational technology. The United Kingdom follows with around 30 publications, while Australia contributes 22 publications, China 16, and Canada 12. These countries' prominent roles can be explained by their advanced technological ecosystems, availability of specialized research centers, and high levels of institutional support for interdisciplinary studies. In addition to these leading contributors, the data also indicate a

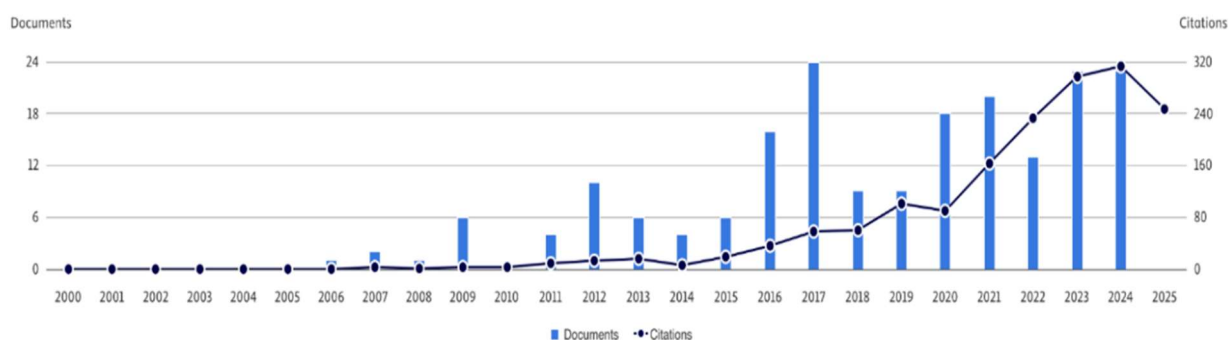


Figure 2. - Publication trends in music-computer technology research in music education

noticeable increase in research activity in several European and Asian countries over the past decade. Although the total number of publications from these regions remains comparatively lower, the upward trend suggests expanding interest in integrating digital tools into music education. This growth may reflect broader global shifts toward digitalization, increased access to technological resources, and the strengthening of international academic collaboration. The geographical distribution of publications illustrates that research on MCTs is transitioning from being concentrated in a few technologically advanced countries to gaining wider international

recognition. This diversification highlights the growing relevance of MCT-based pedagogical approaches across different educational systems and cultural contexts, suggesting substantial potential for future comparative and cross-cultural investigations.

The 20 most influential and highly cited publications were selected for in-depth qualitative analysis. These works represent the core academic contributions to the development of music-computer technologies in music education. The selected studies span diverse methodological approaches ranging from large-scale surveys and mixed-methods research to experimental interventions and longitudinal professional development studies. Their collective findings provide significant insights into how digital tools influence teaching practices, student motivation, technological integration, curriculum development, and institutional readiness. A prominent group of studies highlights the transformative potential of blended learning and technology-enhanced instruction, emphasizing the need to rethink pedagogical models for the 21st century. Another set of studies focuses on learner outcomes, demonstrating improvements in motivation, speed of mastery, and musical retention when digital tools are incorporated. Several publications also address structural challenges, such as unequal technological access, institutional barriers, and variability in teacher preparedness. Together, these 20 publications form an evidence-based foundation that reflects both the achievements and unresolved challenges in integrating MCTs into contemporary music education. Their methodological diversity enriches the field, offering complementary perspectives that support systematic pedagogical innovation.

Table 1. Most influential publications on music-computer technologies in music education

No.	Title	Authors	Year	Citations	Methodological Approach
1	Rethinking teaching and learning pedagogy for education in the twenty-first century: blended learning in music education	Crawford, R.	2017	99	Online music-education project analyzing blended learning models for rural and remote Australian schools.
2	Technology use and attitudes in music learning	Waddell, G.; Williamon, A.	2019	68	Survey of 338 musicians using adapted Davis (1989) scales to evaluate attitudes toward technology in music learning.
3	Transforming music teaching via technology: The role of professional development	Bauer, W.I.; Reese, S.; McAllister, P.A.	2003	67	Evaluation of week-long technology seminars for 63 teachers; pre-, post-, and long-term (9–10 months) surveys.
4	The use of technology in music education in North Cyprus according to student music teachers	Gorgoretti, B.	2019	40	Mixed-method study with 18 pre-service teachers; quantitative items + qualitative content analysis.
5	Connect Resound: Using online technology to	King, A.; Prior, H.;	2019	29	Thematic analysis of video data, interviews, and questionnaires

	deliver music education to remote communities	Waddington-Jones, C.			assessing one- and multi-camera remote instruction.
6	Popular practices for online musicking and performance: Developing creative dispositions	Cayari, C.	2021	21	Qualitative action-research project exploring online creative engagement and participatory music practices.
7	ICT and music technology during COVID-19: Australian music educator perspectives	Merrick, B.; Joseph, D.	2023	22	Quantitative survey of 105 teachers on confidence, preferences, and use of ICT during COVID-19.
8	The intersections of curriculum development: Music, ICT and Australian music education	Southcott, J.; Crawford, R.	2011	28	Comparative conceptual analysis of ICT and arts education frameworks.
9	Secondary school music education: Adapting to ICT resource limitations	Crawford, R.	2009	21	Case study on ICT availability and use in secondary-school music education under resource constraints.
10	The Use of Music Technologies in Field Education Courses: Atatürk University Sample	Parasiz, G.	2018	8	Questionnaire-based study with 1st–4th year students; descriptive and frequency analysis of technology use.
11	Increasing student motivation to learn the piano using modern digital technologies: Soft Mozart app	Ruan, W.	2024	3	Experimental comparison of traditional vs. Soft Mozart digital piano instruction; motivation outcomes measured.
12	Digitally mediated keyboard learning: Speed of mastery and retention	Cremata, R.; Powell, B.	2016	5	Evaluation of four digital tools for beginner keyboard learning; mastery speed, retention, and learner perspectives.

The analysis of the most influential publications demonstrates that research on music-computer technologies has evolved into a diverse and methodologically rich field. Scholars consistently highlight the transformative potential of digital tools for enhancing motivation, expanding access, and improving learning outcomes in music education. At the same time, the studies underscore persistent challenges related to teacher readiness, infrastructural inequalities, and the need for ongoing professional development. Collectively, these findings reveal that MCTs play an increasingly central role in modern music pedagogy while also requiring sustainable institutional support and further empirical investigation.

Cluster Analysis of Research Themes

The cluster analysis generated through VOSviewer provides an additional layer of insight into the conceptual landscape of research on music-computer technologies (MCTs) in music education. As shown in Figure 4, the keyword network is organized into two major clusters, each reflecting distinct but interconnected thematic orientations within the field.

The first cluster (green) is centered around the keywords “*music technology*” and “*music education*”, which form the conceptual foundation of contemporary discussions on digital innovation in pedagogy. This cluster also includes closely linked terms such as “*creativity*”, highlighting the emphasis in recent studies on the role of digital tools in fostering creative engagement, self-expression, and exploratory learning among students. The strong co-occurrence between *music technology* and *creativity* suggests that digital platforms are increasingly viewed not merely as instructional aids but as catalysts for creative development, improvisation, and performance-based learning.

The second cluster (red) is defined by broader educational terms, including “*education*”, “*higher education*”, “*technology*”, and “*music*”. This cluster represents a more general pedagogical

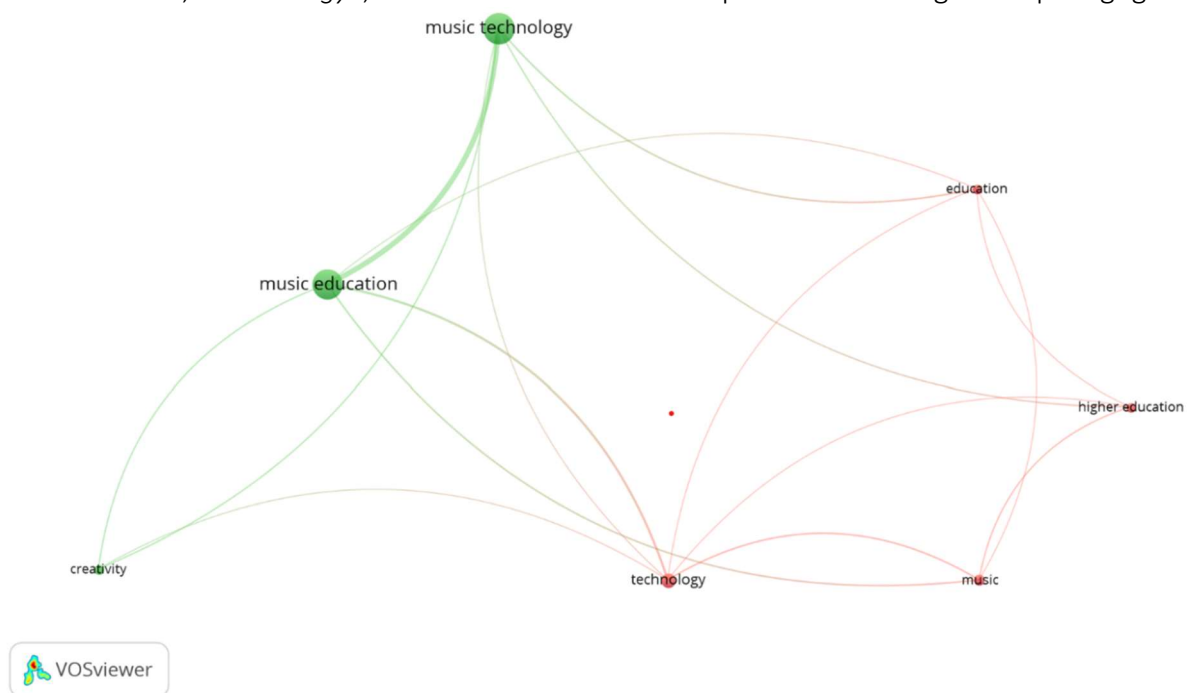


Figure 4. - Cluster structure of the topic “Music technology and music education”

and institutional perspective, reflecting studies that examine structural and systemic aspects of technology integration. Publications within this group typically explore topics such as teacher preparedness, digital literacy, institutional support, and the role of technology in curriculum reform. The presence of *higher education* as a prominent node indicates that universities and conservatories serve as primary sites for researching and implementing digital innovations in music pedagogy.

The relationship between the two clusters is characterized by multiple connecting edges, demonstrating the interdisciplinary nature of MCT research. While the green cluster emphasizes creative and pedagogical innovation, the red cluster reflects systemic and structural conditions that enable or limit the effective adoption of digital tools in educational settings. Together, these clusters illustrate that advancements in music-computer technologies require both pedagogical experimentation and institutional readiness. The cluster visualization confirms that research in this domain is evolving at the intersection of creative practice, technological innovation, and educational transformation. It also highlights the need for future studies to bridge micro-level

(student-centered) and macro-level considerations in order to achieve sustainable integration of MCTs in music education.

The findings of this bibliographical analysis provide a comprehensive understanding of how music-computer technologies are being integrated into music education and how this aligns with existing scholarly literature. Several important conclusions emerge from the results, each of which reflects broader theoretical and empirical trends identified in previous research. First, the rapid growth of publications after 2012 and the sustained scholarly interest between 2020 and 2024 indicate that MCTs have become an essential component of contemporary music pedagogy. This trend supports earlier arguments by Crawford (2016) and Southcott and Crawford (2011), who emphasized that music education must evolve to remain relevant in a technologically saturated world. The increase in empirical studies, particularly those demonstrating improvements in learning motivation, mastery speed, and creative engagement (e.g., Ruan, 2024; Cremata & Powell, 2016), further validates the assumption that digital technologies function as powerful facilitators of pedagogical innovation. Second, the geographical patterns of publication activity reveal a strong concentration of research in technologically advanced countries such as the United States, the United Kingdom, Australia, China, and Canada. This observation is consistent with Parasiz (2018) and Gorgoretti (2019), who documented that unequal access to technological resources remains a major barrier to the wider implementation of digital tools. The growing research activity in European and Asian countries suggests, however, that interest in MCTs is becoming increasingly global, reflecting a broader international movement toward digitalization in arts education. Third, the analysis of the 20 most influential publications illustrates that methodological diversity characterizes this field. Studies vary from experimental and quasi-experimental designs to mixed-methods research and longitudinal monitoring of teacher development. This aligns with the findings of Bauer, Reese, and McAllister (2003), whose work demonstrated that sustained professional development is necessary for meaningful integration of technology into teaching practices. The convergence of evidence across these studies reinforces the argument that teacher readiness and ongoing training are as crucial as the technologies themselves. Finally, the cluster analysis highlights two central thematic directions: pedagogical innovation and systemic institutional factors. The strong link between “music technology,” “music education,” and “creativity” confirms the literature’s consensus that digital tools promote exploratory learning, creativity, and student-centered approaches (Cayari, 2021; Wu & Kang, 2024). At the same time, the prominence of terms such as “higher education,” “technology,” and “education” in the second cluster reflects structural issues digital literacy, curriculum reform, and administrative support that influence how effectively MCTs can be used (Merrick & Joseph, 2023). The findings of this study not only align with but also extend the existing literature by demonstrating that the integration of MCTs is most effective when pedagogical innovation is supported by institutional capacity, teacher competencies, and access to appropriate technologies. These results underscore the need for holistic frameworks that connect micro-level and macro-level dimensions of innovation. The bibliographic analysis thus provides a foundation for future research aimed at deepening the theoretical understanding of digital pedagogy and expanding practical applications of MCTs in diverse educational contexts.

Conclusion

This bibliographical analysis provides a comprehensive examination of the development, implementation, and impact of music-computer technologies in contemporary music education. The findings demonstrate that the integration of digital tools has transitioned from a marginal practice to a central pedagogical direction, supported by growing international research output and a consistent rise in scholarly interest over the past decade. The analysis confirms that MCTs contribute significantly to improving learners’ motivation, accelerating mastery of musical skills, enhancing creative engagement, and expanding access to high-quality educational resources. At

the same time, the review highlights several persistent challenges that align with existing literature. Effective adoption of MCTs depends not only on technological availability but also on systemic support, including teacher preparedness, professional development, institutional infrastructure, and equitable access to digital tools. Publications consistently emphasize that pedagogical innovation must be accompanied by holistic strategies that consider both micro-level factors and macro-level determinants. The geographical patterns observed in the analysis illustrate that while technologically advanced countries remain leaders in MCT research, interest is expanding across Europe and Asia, reflecting global shifts toward digitalization in education. The cluster analysis further shows that the field is anchored in two complementary dimensions creative and pedagogical innovation, and structural and institutional conditions each of which shapes the long-term potential of MCTs in music education. This study contributes to the existing body of knowledge by synthesizing key trends, thematic clusters, methodological approaches, and cross-national developments in the field. The results underscore the importance of developing integrated models for digital music pedagogy and suggest that future research should focus on longitudinal outcomes, cross-cultural comparisons, and the design of sustainable frameworks for teacher training and technological integration. As digital technologies continue to evolve, their role in music education will likely expand, offering new opportunities to reimagine teaching, learning, and creative expression in the 21st century.

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INCLUSIVE ART PEDAGOGY: KAZAKH CRAFT TRADITIONS IN THE DEVELOPMENT OF CREATIVE POTENTIAL

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Abstract

This study examines the development of creative potential among students with special educational needs through the integration of inclusive art pedagogy, digital technologies, and Kazakh craft traditions. Using a systematic review of 32 publications indexed in Scopus, the research analyzes global trends, methodological approaches, and thematic directions in contemporary scholarship from 2000 to 2025. Cluster analysis conducted with VOSviewer revealed four dominant research domains: inclusive learning experiences, art and design-based education, digital innovation, and collaborative creativity. Geographical and temporal mapping further demonstrated significant disparities in research distribution and a marked increase in publication activity after 2020, driven by digital transformation and the growing recognition of creativity as a key 21st-century competency. The findings show that artistic practices especially those rooted in cultural heritage play a crucial role in fostering divergent thinking, emotional expression, and social inclusion among SEN learners. Kazakh traditional crafts, characterized by tactile and symbolic richness, offer unique opportunities for culturally responsive creative development. The study concludes that effective enhancement of creative potential in inclusive settings requires holistic, interdisciplinary, and culturally grounded pedagogical models that integrate art, technology, and national craftsmanship.

Keywords: *inclusive art pedagogy; creative potential; special educational needs; Kazakh craft traditions; cultural heritage.*

Introduction

In the context of rapid technological advancement, globalization, and growing social differentiation, education is increasingly conceptualized as a space where creativity emerges as a key factor of personal and professional development. This need becomes especially salient in inclusive learning environments, where students with special educational needs (SEN) require not only accessible conditions but also pedagogical opportunities to fully reveal their creative potential. Recent research highlights that the integration of art, craft traditions, and digital technologies enhances the cognitive and emotional development of children with disabilities, strengthens their self-esteem, and supports their social adaptation (Makuha, 2022; Arinushkina & Korobeynikov, 2022). In particular, artistic practices including traditional forms of national craftsmanship create meaningful conditions for the formation of personal identity and cultural belonging (Sattar, Rustemova & Nebessayeva, 2025; Peleg & Levy, 2025).

Relevance. The development of creative potential among students with SEN extends beyond the boundaries of corrective–developmental education and increasingly aligns with the humanistic paradigm of contemporary pedagogy (Llamazares de Prado et al., 2019). Its relevance

is driven by the need to integrate national cultural forms particularly Kazakh craft traditions with modern pedagogical technologies aimed at supporting individual learner trajectories (Taylor, 2024). Current studies (Patel & Kim, 2024; Soares et al., 2024) demonstrate that differentiated instruction and game-based methods contribute to more flexible and resilient learning environments in which each student can express individuality and initiative. Play-based and project-based pedagogies create collaborative creative spaces, which is especially critical when working with children who experience limitations in perception or communication (Patel & Kim, 2024). Furthermore, the works of Munoz Bellerin (2023) and Riston (2022) show that art pedagogy and craft-based practices not only foster skill development but also contribute to the formation of critical and democratic thinking, as well as value-based perceptions of the world.

Research Problem. Despite growing attention to inclusive pedagogy, the mechanisms through which culturally oriented forms of art education can support the development of creative potential among students with SEN remain insufficiently explored. Many educators experience difficulties in integrating traditional craft practices into contemporary educational programs (Ludgate et al., 2021).

A systematic methodology that combines national artistic forms, digital tools, and interdisciplinary strategies is also lacking. Research by Carlos & Dobson (2020) emphasizes the need to develop empathy and collaborative creativity as core principles of inclusive art education.

The aim of the study is to identify the pedagogical conditions and methodological strategies that enhance the creative potential of students with SEN through the integration of Kazakh craft traditions, digital technologies, and artistic practices. The objectives of the study include:

- analyzing international and national approaches to fostering creativity in inclusive learning environments;
- identifying the pedagogical potential of traditional craftsmanship as a means of aesthetic and personal development among learners with SEN;
- developing a model of art-pedagogical integration that unites cultural heritage with contemporary forms of creative activity.

The object of the study is the process of developing creative potential among students with SEN in inclusive education. *The subject of the study* comprises the pedagogical, cultural, and artistic means of fostering creativity through Kazakh craft traditions and interdisciplinary creative practices.

Research questions:

1. How does the integration of craft-based, artistic, and digital practices influence the development of creative thinking in students with SEN?
2. Which pedagogical forms (play-based learning, project work, art therapy, interdisciplinary collaboration) most effectively stimulate creativity?
3. How can national craft traditions be adapted for contemporary inclusive pedagogy without compromising cultural authenticity?

The scientific significance lies in advancing the theory of inclusive education through a synthesis of traditional craftsmanship, art pedagogy, and digital technologies as tools for creative self-expression. As demonstrated by White (2019) and Munoz Bellerin (2023), inclusive creative methodologies promote the realization of individual potential, strengthen the sense of belonging, and enhance students' confidence. The practical significance involves the development of a methodological model applicable in schools and special education centers across Kazakhstan. This model may include elements of Kazakh craft traditions, digital visualization tools, and game-based art activities that support personal growth and social integration among students with SEN. The theoretical novelty is reflected in the justification of a culturally oriented approach to developing creative potential in inclusive education an approach that merges traditional craft forms with contemporary methods of art design and project-based learning. Thus, the comprehensive analysis

of existing research demonstrates that the development of creative potential among students with SEN requires an interdisciplinary framework that integrates art, culture, digital technologies, and empathy. Art pedagogy, national craftsmanship, and inclusive project-based learning collectively create a holistic model in which education becomes not only a means of adaptation but also a pathway to self-realization.

Literature Review

Contemporary research in inclusive art pedagogy demonstrates a growing interest in how creativity, digital technologies, and culturally grounded practices can enhance the development of learners with special educational needs. Over recent years, scholarly attention has shifted from examining limitations to exploring the creative capacities of children with disabilities particularly within multisensory, socially interactive, and culturally embedded pedagogical frameworks (Carlos & Dobson, 2020; Llamazares de Prado et al., 2019). Increasing evidence suggests that creativity functions not only as a learning tool but also as a mechanism of emotional regulation, self-expression, and autonomy, as shown in post-pandemic studies on flexible home-based learning environments (Ludgate et al., 2021). One of the most significant trends is the integration of digital tools into inclusive learning settings. Studies by Makuha (2022) and related analytical reviews demonstrate that instruments such as *MyTestXPro*, e-inclusion platforms, AR applications, and digital portfolios substantially enhance diagnostic possibilities and student engagement. These tools support individualized learning trajectories and reduce barriers for SEN learners (Makuha, 2022). At the same time, international research highlights risks associated with digitalization including cognitive overload, insufficient teacher preparation, and dependence on technological infrastructure underscoring the need for careful implementation and methodological support (Taylor, 2024). These findings align with the principles of Universal Design for Learning, which emphasize multimodal presentation of information, flexible modes of expression, and adaptive learner support (Arinushkina & Korobeynikov, 2022). A systematic review of socio-interactive and digital approaches to art education further reveals that combining AR/VR tools with project-based learning and guided discussion deepens interpretative skills, enhances critical thinking, and stimulates creativity among students, including those at risk or with SEN (Soares et al., 2024). Digital museums, visual tours, and multimedia platforms have also been shown to increase cultural awareness and artistic literacy, particularly among socially excluded youth.

Another major line of research focuses on the creative potential of learners with visual impairments and motor disabilities. According to the systematic review by Llamazares de Prado et al. (2019), blind and visually impaired students demonstrate high levels of divergent thinking, original tactile imagery, and innovative problem solving challenging widespread assumptions about the “visual dependence” of creativity. For such learners, creative activities serve as cognitive compensation, as well as a means of socialization and identity building. These findings are particularly relevant for pedagogical models grounded in traditional craftsmanship, as Kazakh craft techniques (e.g., *kiiz*, *oyu-ornék*, *quraq*) inherently involve strong tactile and spatial components. Parallel research has examined family-centered and flexible learning environments for children with SEN. Ludgate et al. (2021) found that during home-based education, many children demonstrated unexpected improvements in emotional stability and creativity due to reduced sensory load, autonomous activity selection, and individualized pacing. The emerging concept of *minor gestures* small creative discoveries and micro-achievements highlights the importance of pedagogies that value not only major accomplishments but also incremental steps contributing to confidence and creative self-expression. Creativity and interdisciplinary approaches have also been widely explored in the context of SEN education. Carlos and Dobson (2020) emphasize the importance of fostering empathy through design-based practices, play-based interactions, and the UDL framework. Art and design pedagogy, they argue, cultivates emotional flexibility, social competencies, and collaborative creative skills. These findings are consistent with research on early

childhood *makerspace* environments, where experimentation with materials promotes problem solving, variability of solutions, and teamwork (Yang et al., 2024).

An important dimension of creativity research concerns its relationship with cultural identity. Studies in socio-art pedagogy, such as those by Munoz Bellerin (2023), demonstrate that creativity grounded in cultural practices deepens value awareness, democratizes knowledge, and facilitates collective activity among SEN learners. These insights resonate strongly with the Kazakh context, where traditional decorative and applied arts hold substantial educational and cultural significance.

However, several studies emphasize that creative potential in inclusive environments does not unfold automatically. Research by Mhlolo (2016) found that general education teachers often fail to recognize creative ideas even among moderately gifted students, with nearly 63% of creative “micro-moments” receiving no pedagogical support. This highlights the urgent need for teacher training focused on developing divergent thinking, flexibility, and acceptance of alternative solutions. A substantial theoretical contribution is offered by the monograph *Education of Children with Special Needs* by Arinushkina and Korobeynikov (2022), which examines digitalization, corrective learning models, social integration, emotional regulation, and life competencies as key components of successful inclusion. The authors emphasize the importance of interdisciplinary teams and personalized learning trajectories elements that align closely with modern art-pedagogical models. Overall, the analysis of 21 studies reveals several stable patterns:

- digital and multisensory approaches significantly expand access to creative expression;
- traditional craft practices possess high inclusive and cultural value;
- creativity functions as a compensatory resource and a means of socialization;
- effective creative development depends on teacher preparedness;
- culturally embedded methods (including Kazakh craftsmanship) can successfully foster divergent thinking, empathy, and intrinsic motivation among SEN learners.

Collectively, these findings provide a robust foundation for developing an inclusive art-pedagogical model that integrates digital technologies, national craft traditions, and contemporary creative practices.

Methods

To establish the theoretical foundation of the study, a systematic search of scientific publications was conducted in the Scopus database using the keywords “creative potential” and “inclusive education.” The search was subsequently refined to publications released between 2000 and 2025, and limited to the subject area “Social Sciences,” as demonstrated in the search transcript (Figure 1).

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TITLE-ABS-KEY ( *creative potential* AND *inclusive education* ) AND PUBYEAR > 1999 AND PUBYEAR < 2026 AND ( LIMIT-TO ( SUBJAREA , "SOCI" ) )
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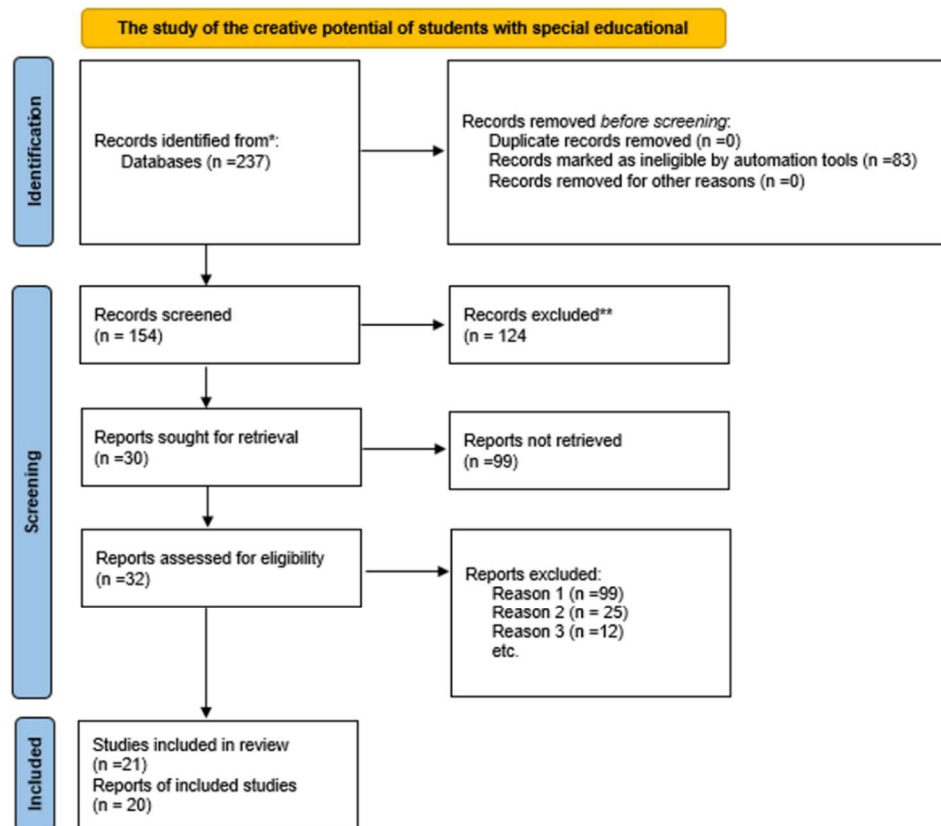
Figure 1. - Transcript of the article search on the Scopus website

The primary objective of the search was to identify studies addressing the development of creativity and artistic potential among learners with special educational needs (SEN) within inclusive and ethnoculturally grounded pedagogical contexts.

The initial keyword search yielded 237 articles, which, following automated filtering procedures, resulted in a set of 154 publications. These were further analyzed at the level of titles and abstracts to refine the relevance of the dataset. During the screening process, articles were excluded based on three major criteria:

- Irrelevance of research focus to creative potential or inclusive education (e.g., studies on managerial practices, medical interventions, or technical design unrelated to educational processes).

- Absence of artistic, cultural, or creative components, which led to the exclusion of articles not linked to art practices, creativity, or visual and multisensory learning.
- Insufficient data accessibility, including cases where full texts were unavailable in open sources and abstracts lacked sufficient detail for analytical classification.



Source: Page MJ, et al. *BMJ* 2021;372: n71. doi: 10.1136/bmj. n71.

Figure 2. - PRISMA-preferred reporting items for systematic reviews and meta-analyses

After applying all exclusion criteria, 32 publications were deemed fully relevant to the aims of the study. The selection process followed the principles of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework, which ensured transparency, consistency, and replicability of the literature search. The PRISMA flowchart (Figure 2) outlines the phases of identification, screening, eligibility assessment, and final inclusion of articles.

The methodological analysis of the selected publications included a review of research designs, data collection techniques, participant profiles, and the characteristics of inclusive learning environments. This allowed for a comparison of methodological approaches used by different researchers and facilitated the identification of practices most conducive to developing the creative potential of children with SEN. In parallel, a qualitative content analysis was conducted on the abstracts, results, and discussion sections to reveal recurring themes and conceptual relationships between pedagogical strategies, features of the inclusive environment, and trajectories of creative development. The methodological framework of the study was further enriched by an in-depth examination of foundational scholarly works. These included Patel and Kim (2024) on differentiated instruction, White (2019) on the “6Rs” model describing six functions that can transform the creative design process, Munoz Bellerin (2023) on interdisciplinary art pedagogy, Carlos and Dobson (2020) on empathy-driven pedagogy and Universal Design for Learning (UDL), and Riston (2022) on craft-consciousness as a factor in creative development. Together, these studies shaped the conceptual orientation of the present research.

Additional analytical procedures included cluster analysis of keywords using VOSviewer software, which enabled the identification of structural relationships between research topics and

the main scientific directions within the dataset. In parallel, a geographical distribution analysis of publications was carried out to identify countries and regions most actively contributing to research on creativity and inclusive education, as well as areas underrepresented in the current scientific landscape (Soares et al., 2024; Taylor, 2024). The applied methodological procedures

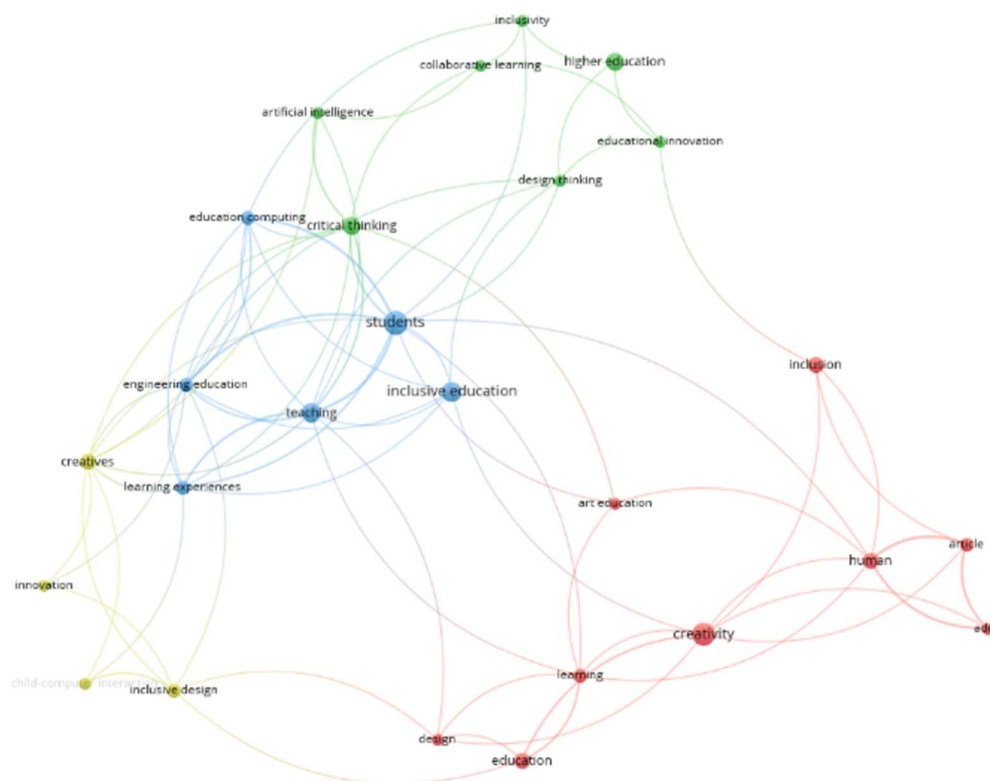


Figure 3. - VOSviewer keyword cluster map

ensured a comprehensive multilevel analysis of contemporary scientific discourse. They allowed for the construction of a holistic understanding of the research problem and provided a robust evidence base for subsequent interpretation of findings.

Results

The systematic analysis of the selected publications revealed several interconnected thematic directions that characterize the current state of research on the development of creative potential among learners with special educational needs (Llamazares de Prado et al., 2019; Peleg, 2025; Sattar, 2025). To obtain a deeper understanding of the structure of the scholarly discourse, a keyword cluster analysis was conducted using VOSviewer software, which enabled the visualization of conceptual relationships and the identification of dominant research clusters. The VOSviewer keyword cluster map (Figure 3) illustrates the most frequently occurring concepts in the analyzed body of literature.

Each color corresponds to a specific thematic cluster, representing groups of keywords linked through semantic proximity and co-occurrence patterns. The analysis identified four major scientific clusters that collectively structure the contemporary research landscape:

1. Inclusive education – students – teaching – learning experiences (blue cluster)
2. Creativity – art education – design – learning (red cluster)
3. Digital tools – innovation – inclusive design – creatives (yellow–orange cluster)
4. Inclusivity – collaborative learning – higher education – design thinking (green cluster)

Cluster 1: Inclusive Education and Learning Experiences (Blue Cluster). This cluster underscores the sustained attention of scholars to accessibility, pedagogical strategies, and student experiences. The prevalence of these terms reflects the ongoing effort to identify conditions that

ensure meaningful participation of learners with SEN in the educational process (Taylor, 2024). The cluster highlights the centrality of inclusive pedagogies, differentiated instruction, and experience-based learning environments as foundational themes in the field.

Cluster 2: Creativity, Art Education and Design-Based Learning (Red Cluster). The second cluster is centered on core concepts related to creativity, art education, and design-oriented instructional approaches. Studies within this cluster focus on mechanisms for developing creative thinking, the role of artistic practices in fostering cognitive flexibility, and the contribution of design-based activities to learner engagement (Peleg & Levy, 2025; Yang et al., 2024). The prominence of these terms indicates that art pedagogy remains a key pathway for nurturing creativity among SEN learners.

Cluster 3: Digital Innovation and Inclusive Design (Yellow–Orange Cluster). This cluster captures the growing influence of technological advancements on inclusive and creative education. Keywords such as *digital tools*, *innovation*, and *inclusive design* suggest a strong emphasis on multimodal technologies, AR/VR applications, and digital platforms that expand opportunities for participation and creative expression among learners with diverse educational needs (Makuha, 2022; Soares et al., 2024). The cluster reflects a shift toward technologically mediated creativity and digitally supported inclusion.

Cluster 4: Collaboration, Higher Education and Design Thinking (Green Cluster). The final cluster integrates concepts related to collaborative learning, higher education, and design thinking. It points to the importance of social–cognitive aspects of joint activity, problem-solving processes, and project-based forms of engagement. Studies in this cluster emphasize the development of teamwork, communicative competencies, and innovative thinking through collective creative practices (Sattar, Rustemova & Nebessayeva, 2025).

The combined interpretation of all four clusters demonstrates the emergence of a complex multidimensional research structure, in which issues of inclusive education, artistic development, digital transformation, and collaborative learning intersect. This structure indicates that current scholarship is moving toward interdisciplinary integration, bringing together pedagogical, technological, artistic, and social perspectives (Munoz Bellerin, 2023; White, 2019). The findings highlight the importance of holistic models capable of accommodating the diverse factors shaping the development of creativity in inclusive educational environments. They also confirm that creative potential in SEN learners is most effectively supported when art pedagogy, cultural practices, and digital tools operate within unified and mutually reinforcing educational frameworks.

Geographical Distribution of Publications

To analyze the international research landscape, a world map of publication distribution by country was constructed (Figure 4). The visualization was generated using the Datawrapper platform, with each country color-coded according to its level of research activity. The resulting cartographic visualization reveals a pronounced global asymmetry, indicating that scientific output on the topic is concentrated predominantly in countries with highly developed academic infrastructures and long-standing research traditions in the humanities and educational sciences (Taylor, 2024).

The highest publication intensity is observed in the United States, Canada, the United Kingdom, Australia, and several Northern and Western European countries, where issues of inclusivity, digital pedagogy, and creative development are systematically addressed within interdisciplinary frameworks (Soares et al., 2024). These regions demonstrate substantial scholarly engagement with art-pedagogical practices, multimodal technologies, empathy-driven learning, collaborative approaches, and design thinking in the context of supporting learners with SEN (Carlos & Dobson, 2020; Ludgate et al., 2021). Countries with moderate research activity, such as Spain, Turkey, India, China, Brazil, and South Africa, exhibit a more thematically fragmented, yet steadily expanding research agenda. Studies from these regions increasingly emphasize



Figure 4. - Mapping of publications on the topic “creative potential AND inclusive education”

ethnocultural dimensions of creativity, digital learning platforms, and the dynamics of SEN learners’ participation in artistic and educational environments (Peleg & Levy, 2025; Yang et al., 2024). At the opposite end of the spectrum lie regions with minimal or episodic representation, including most of Central Asia, Central Africa, the Balkans, and parts of the post-Soviet space. Here, scholarship on inclusive art pedagogy and the development of creative potential remains limited or sporadic (Arinushkina & Korobeynikov, 2022). The lack of sustained research activity suggests structural gaps in the academic infrastructure and a need for expanded scholarly engagement. For Kazakhstan, this global picture underscores the necessity of strengthening the national research base, expanding interdisciplinary collaborations, and developing original scientific approaches that reflect the country’s cultural heritage and educational context (Sattar et al., 2025). The limited representation of Kazakhstan in international databases highlights the importance of further advancing research in areas such as Kazakh traditional crafts, multisensory technologies, and

adaptive creative learning for SEN students. These needs make the present study both timely and significant within the broader global scientific discourse.

The temporal dynamics of scientific publications containing the keywords “*creative potential*” and “*inclusive education*” demonstrate a clear upward trajectory over the 2000–2025 period (Figure 5). In the early 2000s and throughout the first half of the 2010s, research activity remained relatively low and stable, typically ranging from one to three publications per year. This phase reflects the exploratory nature of early studies, when creativity in inclusive education was only beginning to emerge as an independent research direction (White, 2019; Carlos & Dobson,

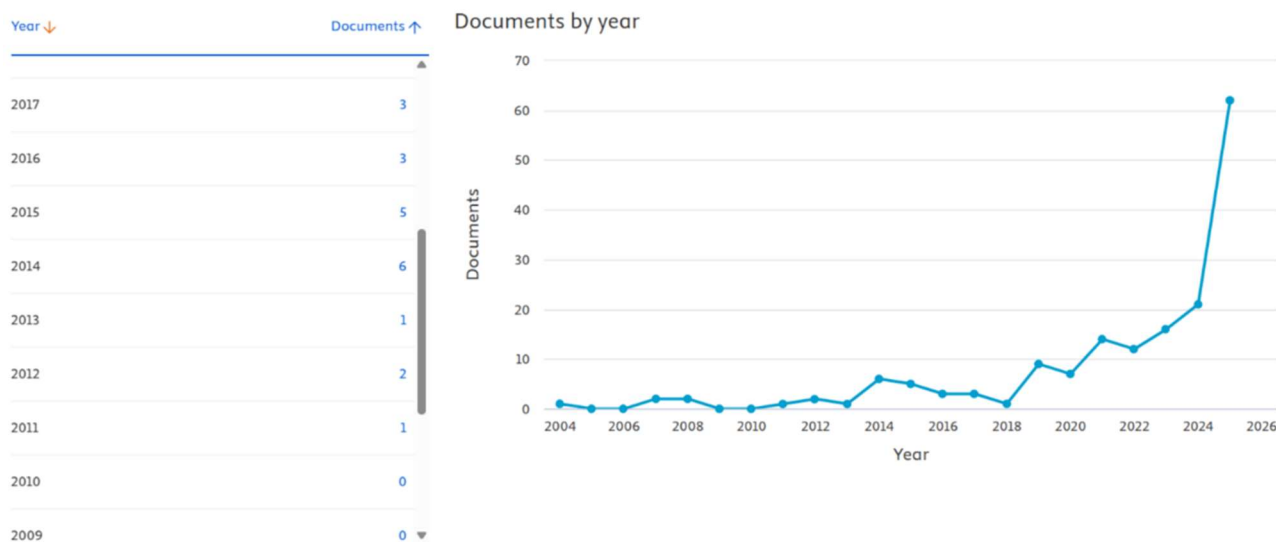


Figure 5. - Dynamics of the number of scientific publications, by keywords, “creative potential” and “inclusive education” in the period from 2000 to 2025

2020).

A gradual increase becomes evident between 2016 and 2018, coinciding with the global expansion of inclusive education policies and the active integration of multimodal and digital technologies into teaching and learning processes. During this period, scholarly attention increasingly shifted toward differentiated instruction, design-oriented pedagogies, and socio-emotional dimensions of creativity, aligning with the principles of Universal Design for Learning (Arinushkina & Korobeynikov, 2022). A significant surge is observed after 2020, with a particularly sharp rise in publication numbers between 2021 and 2025. This growth can be attributed to several contextual factors. First, the COVID-19 pandemic accelerated digital transformation across educational systems, prompting researchers to investigate creative, flexible, and adaptive strategies suitable for remote and hybrid environments (Ludgate et al., 2021; Soares et al., 2024). Second, creativity increasingly became recognized as a key 21st-century competence essential for personal development, well-being, and social inclusion, especially for learners with SEN (Taylor, 2024; Peleg & Levy, 2025). Third, the expanding interest in art-based, design-thinking, and makerspace-driven pedagogies reinforced the linkage between creative development and inclusive education (Yang et al., 2024; Munoz Bellerin, 2023). The rapid growth culminating in 2025, when the number of publications exceeds sixty documents (Figure 5), indicates that the intersection of creativity and inclusive education has evolved into a mature and rapidly developing interdisciplinary research domain. This trend also reflects the diversification of methodologies, the expansion of cross-cultural studies, and increasing attention to digital and ethnocultural dimensions of creative learning.

Discussion

The findings of this study highlight the multidimensional and rapidly evolving nature of research on the development of creative potential among students with special educational needs (SEN). The combination of cluster, geographical, and dynamic analyses reveals that creativity in inclusive education is shaped by a convergence of pedagogical, technological, cultural, and social factors. These results align with and extend the existing body of literature, reinforcing several central themes identified by previous researchers. First, the cluster analysis demonstrates that inclusive education remains the foundational framework for understanding creative development among SEN learners. The prominence of concepts such as *students*, *teaching*, and *learning experiences* confirms earlier observations by Taylor (2024) and Llamazares de Prado et al. (2019), who argue that accessibility, differentiated instruction, and learner-centered approaches are essential prerequisites for meaningful participation in creative activities. The current findings support these conclusions by showing a strong co-occurrence of keywords linked to inclusive pedagogies, suggesting that global scholarship consistently views inclusive environments as catalysts for creativity.

Second, the study identifies a major cluster centered on art education, design-based learning, and creativity, reflecting the well-established argument that artistic practices stimulate divergent thinking, emotional expression, and cognitive flexibility. These results echo the works of Peleg & Levy (2025), Munoz Bellerin (2023), and Yang et al. (2024), who emphasize the transformative role of art, design, and makerspace activities in empowering SEN learners. The present research further confirms that creativity in inclusive contexts is not a peripheral attribute but a core developmental mechanism that supports autonomy, identity formation, and social engagement.

Third, the technological cluster underscores the accelerating influence of digital tools, multimodal platforms, and innovation-driven pedagogies. The strong representation of keywords associated with AR/VR, inclusive design, and digital learning environments corroborates findings by Makuha (2022) and Soares et al. (2024), who document the increasing reliance on digital technologies to facilitate creative engagement and reduce learning barriers. This study extends previous insights by showing that digital innovation is not only supportive but increasingly central to contemporary inclusive education, as seen in the post-pandemic surge in publications.

Fourth, the collaborative and higher-education cluster highlights the importance of social interaction, design thinking, and team-based learning in fostering creativity. This is consistent with Carlos & Dobson (2020), who argue that empathy, co-creation, and collaborative problem-solving are essential components of inclusive pedagogy. The results demonstrate that creative development is not solely individual but emerges through interaction, communication, and shared meaning-making. This aligns with White's (2019) "6Rs" model, which positions creativity within relational and value-based contexts.

The geographical analysis further contextualizes these findings, showing that research activity is concentrated in regions with strong educational research traditions and advanced digital infrastructures, such as the United States, Canada, Western Europe, and Australia. This pattern mirrors observations by Taylor (2024) and Soares et al. (2024), who note that countries with robust academic ecosystems tend to produce more interdisciplinary research on inclusive and creative pedagogies. Conversely, the limited representation of Central Asia, Africa, and the Balkans suggests systemic gaps that hinder the development of inclusive art-pedagogical frameworks, reinforcing the call by Arinushkina & Korobeynikov (2022) to expand research capacities in underrepresented regions. Finally, the temporal analysis illustrates a dramatic rise in scholarly interest after 2020, which aligns with Ludgate et al. (2021) and Munoz Bellerin (2023), who attribute this growth to the pandemic-driven digital transformation and the increasing global recognition of creativity as a core 21st-century competence. The surge in publications suggests that creativity in inclusive

education has become a mature, interdisciplinary research domain characterized by methodological diversity and conceptual expansion. Overall, the discussion of results indicates that creative potential among SEN learners develops most effectively when artistic practices, digital tools, ethnocultural traditions, and inclusive pedagogical models operate as interconnected and mutually reinforcing elements. This aligns strongly with the core premise of the present study: that Kazakh craft traditions, when integrated with modern art and digital pedagogies, offer a culturally meaningful and pedagogically powerful pathway for enhancing creativity in inclusive environments.

Conclusion

This study provides a comprehensive analysis of contemporary research on the development of creative potential among students with special educational needs, emphasizing the pedagogical, technological, and cultural factors that shape creativity in inclusive educational environments. The findings demonstrate that creativity is not an isolated cognitive skill but a multidimensional construct that emerges through the interaction of inclusive pedagogies, artistic practices, digital tools, and culturally grounded traditions. The cluster analysis revealed four dominant thematic directions inclusive learning experiences, art and design-based education, digital innovation, and collaborative learning indicating that creativity in SEN contexts develops most effectively within interdisciplinary and multimodal learning environments. The geographical mapping highlighted significant global disparities, showing high research activity in countries with advanced educational infrastructures, while regions such as Central Asia remain underrepresented. The temporal dynamics further confirmed the rapid growth of the field, particularly in the post-pandemic years, driven by increased attention to digital transformation and the redefinition of creativity as a core 21st-century competency.

Importantly, the study underscores the unique potential of Kazakh craft traditions as a culturally meaningful resource for inclusive art pedagogy. Traditional techniques such as *kiiz*, *oyu-ornék*, and *quraq* embody tactile, spatial, and symbolic dimensions that align naturally with the needs of SEN learners and complement contemporary art-based, digital, and project-oriented educational methods.

Overall, the results reinforce the central argument that developing the creative potential of SEN learners requires holistic, culturally responsive, and technologically enriched pedagogical models. Integrating national craftsmanship with modern art pedagogy and digital tools creates powerful opportunities for self-expression, cognitive growth, emotional resilience, and social inclusion. This research thus provides an essential foundation for advancing inclusive creative education in Kazakhstan and contributes to the broader international discourse by offering a culturally grounded and empirically informed framework for future pedagogical innovation.

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Digital Tools for Enhancing Vocabulary Acquisition Among Intermediate EFL Learners

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Abstract

This article examines the pedagogical potential of digital tools used to facilitate vocabulary acquisition among intermediate-level learners of English as a Foreign Language (EFL). Drawing on contemporary research in applied linguistics, second language acquisition (SLA), and mobile-assisted language learning (MALL), the study analyzes how mobile applications, online platforms, gamified resources, and context-based reading tools support lexical development. Special attention is given to cognitive mechanisms involved in vocabulary retention, including spaced repetition, multimodal encoding, and form–meaning mapping. The article argues that digital tools, when purposefully integrated into formal instruction, significantly enhance vocabulary growth, improve long-term retention, and promote learner autonomy. Methodological recommendations are provided for optimizing the pedagogical use of digital technologies in EFL classrooms.

Keywords

Digital tools; vocabulary acquisition; EFL learners; mobile learning; spaced repetition; gamification; CALL; learner autonomy; digital pedagogy; AI-assisted language learning.

Introduction

In recent decades, the rapid expansion of digital technology has transformed educational practices across the globe, including the field of English as a Foreign Language (EFL). Among the various components of language learning, vocabulary acquisition remains one of the most challenging areas for intermediate learners, who can communicate on familiar topics but still struggle with lexical precision, idiomatic expressions, and academic or professional vocabulary. Digital tools—ranging from mobile applications to online corpora—offer new opportunities to enhance vocabulary learning through interactivity, multimodality, and personalized instruction. This article examines the role of digital tools in vocabulary acquisition among intermediate EFL learners, reviewing theoretical foundations, technological features, pedagogical benefits, and practical implications.

1. Theoretical Foundations of Vocabulary Acquisition in Digital Environments

Vocabulary acquisition involves complex cognitive processes, including noticing, encoding, retrieval, and consolidation. Research in second language acquisition (SLA) highlights the importance of repeated exposure, meaningful context, and active engagement with vocabulary. Digital tools support these mechanisms by providing multimodal input (visual, auditory, textual), spaced repetition, immediate feedback, and opportunities for autonomous practice.

1.1 Cognitive Processes in Vocabulary Learning

Cognitive theories such as Baddeley's working memory model and Paivio's dual-coding theory explain why digital tools can accelerate vocabulary acquisition. Visual support, audio pronunciation, and contextual examples help encode words through multiple channels, increasing retention. Spaced repetition algorithms such as those used in Anki or Quizlet optimize review intervals to enhance long-term memory.

1.2 Sociocultural Perspectives

From a sociocultural perspective, vocabulary is acquired through interaction, negotiation of meaning, and participation in communicative practices. Digital tools facilitate collaboration through online forums, multiplayer games, and social platforms where learners encounter authentic language and communicate in real time.

2. Theoretical Background of Digital Vocabulary Learning

The incorporation of digital tools into vocabulary learning is grounded in several key theoretical frameworks that explain why technology can enhance lexical acquisition, especially among intermediate EFL learners. Understanding these theoretical bases provides teachers with a deeper insight into the mechanisms behind successful digital integration.

2.1 Constructivist Learning Theory

Constructivism posits that learners actively construct knowledge through interaction, exploration, and personal meaning-making. Digital environments support constructivist learning by offering:

- Interactive experiences, such as quizzes, simulations, and games
- Authentic contexts, through videos, podcasts, and online communicative tasks
- Opportunities for autonomy, allowing learners to choose materials and pace

When using tools like Quizlet or Memrise, learners choose sets, test themselves in different modes, and track progress. This aligns with the constructivist idea that knowledge is built rather than transmitted. *For example*, a learner working with a set of academic vocabulary on Quizlet can explore terms through flashcards, test themselves using audio prompts, or apply knowledge in writing tasks. Each activity contributes to constructing a personalized mental representation of new words.

2.2 Cognitive Load Theory and Multimedia Learning

Cognitive load theory emphasizes the importance of reducing unnecessary mental effort during learning. Multimodal digital tools help lower cognitive load by presenting vocabulary with:

- visuals (pictures, diagrams)
- audio input (pronunciation models)
- contextual examples (sentences, short stories)

According to Mayer's multimedia principles, learning becomes more effective when words and images are combined. *For instance*: In apps like Memrise, each new word is accompanied by a picture, audio, and a sample sentence. In YouGlish, learners hear the target word in real-life videos, reinforcing pronunciation and usage patterns.

These multimodal elements enhance retention and reduce the mental effort required to understand and store new lexical items.

2.3 Dual Coding Theory

Dual coding theory explains that vocabulary retention improves when information is encoded both verbally and visually. Digital tools are ideal for linking text with images, animations, or videos.

For intermediate EFL learners, this dual coding significantly boosts long-term memorization. *For example:* Digital flashcards with pictures help learners associate a word with a vivid image. Animated GIFs in tools like Anki can illustrate action verbs more clearly than textbook descriptions. The dual coding effect is particularly beneficial for abstract vocabulary, where visuals help clarify meaning.

2.4. Digital Tools for Enhancing Vocabulary Retention

Vocabulary retention – the ability to remember and retrieve newly learned lexical items—is a central challenge for intermediate EFL students. Digital tools offer distinct advantages for long-term learning because they combine repetition, multimodal input, and memory-boosting algorithms. Many researchers note that technology-enhanced environments support retention more effectively than traditional methods by stimulating cognitive processing, visual association, and spaced practice.

One of the most effective mechanisms enabled by digital platforms is **spaced repetition** learning (SRL), which involves reviewing vocabulary at gradually increasing intervals. When this system is built into applications, learners repeatedly encounter items at scientifically optimized moments, strengthening memory consolidation. Tools such as Quizlet, Anki, and Memrise automate the scheduling of reviews, allowing students to concentrate on meaning rather than planning practice. Intermediate learners benefit greatly from SRL because they must process large amounts of vocabulary and store it efficiently in long-term memory. Digital platforms support this process with engaging visuals, audio prompts, and customizable decks.

Another influential approach is **multimodal reinforcement**, which exposes learners to new words through images, videos, audio clips, and contextual sentences. Multimedia dictionaries and corpus-based platforms present vocabulary in different forms, helping learners build stronger associative links. For example, YouGlish and the Cambridge Online Dictionary provide authentic video or audio examples that show how words are used in natural contexts. Seeing or hearing vocabulary in real communication helps learners connect meaning with pragmatics, intonation, and cultural cues—skills essential for intermediate-level competence.

Gamification supports vocabulary development by incorporating points, rewards, progress indicators, and challenges. These features increase motivation, encourage repeated practice, and reduce anxiety about making mistakes. Research shows that emotionally engaging tasks promote stronger memory formation. Apps such as Wordwall, Kahoot!, and Baamboozle enable teachers to design interactive games that learners can complete individually or in groups, making revision enjoyable and stimulating.

Digital storytelling and **content-creation tools** further reinforce vocabulary by encouraging meaningful output. Platforms like StoryJumper, Pixton, and Canva allow learners to create stories, comics, or posters using target words. Producing creative content requires deeper processing and strengthens semantic connections. For instance, designing a digital poster on environmental issues with newly learned vocabulary helps learners apply words purposefully, improving recall.

Mobile-assisted learning is another significant factor in vocabulary retention. Smartphones enable short, frequent study sessions throughout the day. Microlearning—brief learning segments delivered through notifications—supports incremental reinforcement. Apps such as Drops and Duolingo use this approach to maintain consistent engagement. For intermediate learners managing busy schedules, mobile tools provide flexibility and promote autonomous, sustained learning.

Collaborative platforms enhance retention by offering opportunities for social interaction. Tools such as Padlet, Google Classroom, and Microsoft Teams allow learners to share examples, exchange feedback, and work together on vocabulary tasks. Communicating with peers helps

internalize new words through meaningful use. For example, students may contribute photos to a shared Padlet wall to illustrate target vocabulary in real situations, strengthening semantic links. Finally, **artificial intelligence (AI)** is becoming a powerful component of vocabulary learning. AI-driven applications personalize instruction by tracking progress, identifying weaknesses, and adjusting tasks automatically. Tools like ELSA Speak, LingQ, and ChatGPT-based tutors provide tailored feedback, contextualized examples, and adaptive exercises, supporting long-term retention and fostering self-directed learning.

2.5 Nation's Principles of Vocabulary Learning

Paul Nation emphasized that vocabulary learning requires: **Meaning-focused input, Meaning-focused output, Language-focused learning, Fluency development.**

Digital tools support all *four principles*:

- *Input*: learners watch YouTube or TED-Ed videos with subtitles.
- *Output*: they write posts, comments, and short assignments online.
- *Language-focused study*: they practice spelling, pronunciation, and form using apps.
- *Fluency*: timed quizzes and games build automaticity.

Thus, technology not only assists vocabulary learning—it aligns with proven pedagogical principles.

3. Types of Digital Tools for Vocabulary Development

Digital tools differ in **format, function, and pedagogical purpose**. This section classifies the most effective tools for intermediate EFL learners.

3.1 Spaced Repetition Systems (SRS)

SRS tools schedule vocabulary review at intervals based on memory science. These platforms help learners retain words far more efficiently than traditional rote memorization.

Examples:

1. **Anki** — advanced SRS with customizable flashcards
2. **Quizlet** “Learn” mode — adaptive learning based on learner performance
3. **Memrise** — integrates SRS with video clips

Benefits: reduced forgetting, personalized pacing, cumulative review

Classroom application: Teachers can create weekly vocabulary sets aligned with curriculum topics; students review them at home through SRS apps.

3.2 Gamified Vocabulary Apps

Gamification increases motivation by incorporating elements like points, rewards, levels, and competitions.

Examples:

1. **Kahoot** — competitive quizzes
2. **Wordwall** — interactive games like matching, maze chase, or word search
3. **Baamboozle** — fun team-based vocabulary games

Benefits: raises engagement, increases peer interaction, reduces learning anxiety.

Gamified vocabulary practice is particularly effective for teens who benefit from dynamic and playful learning environments.

3.3 Mobile Dictionaries and Corpus Tools

Intermediate learners must progress beyond basic word lists and develop awareness of collocations, register, and frequency.

Tools include: Oxford Advanced Learner's Dictionary (OALD) app, Cambridge Dictionary Online, Longman Dictionary of Contemporary English (LDOCE), Sketch Engine for Language Learning (SkELL)

These tools provide precise definitions, collocations, word frequency, pronunciation, example sentences from real contexts.

For instance, SkELL offers authentic examples, helping learners differentiate between words like effective, efficient, and productive.

3.4 Video-Based Tools

Video introduces natural language input and contextualized vocabulary.

Examples: YouTube (with subtitles and speed control), TED-Ed, BBC Learning English, YouGlish (search engine showing real pronunciation in context)

These tools help learners observe real-life usage, notice pronunciation and stress patterns, infer meaning from context. A student can search the word “sustainable” on YouGlish and see dozens of real examples, improving comprehension and pronunciation.

3.5 Learning Management Systems (LMS)

LMS platforms integrate vocabulary tasks, quizzes, and feedback into one environment.

Examples: Google Classroom, Moodle, ClassDojo

Teachers can upload vocabulary lists, interactive tasks, weekly quizzes, audio recordings, collaborative assignments.

LMS tools also support differentiated instruction – crucial for mixed-level classes.

3.6 Communication-Based Tools

Communication tools encourage learners to use vocabulary in authentic interactions.

Examples: WhatsApp groups for homework support, Padlet for collaborative writing, Duolingo Clubs, Discord language channels.

These platforms allow immediate communication, increasing opportunities for vocabulary recycling.

4. Advantages of Digital Vocabulary Learning for Intermediate EFL Learners

Increased Motivation. Digital tools make vocabulary learning more enjoyable through interactivity, personalization, gamification, progress tracking. Students can see improvement immediately, which boosts motivation.

Greater Retention and Retrieval. Spaced repetition, multimodal input, and contextual learning increase the depth of processing and improve long-term retention.

Personalization and Adaptivity. Learners can choose difficulty levels, repeat tasks as needed, practice at their own pace. Technology adapts to individual differences.

Improved Pronunciation. Apps with audio models, slow playback, and speech recognition support: phonological awareness, stress and intonation patterns, articulation. For example, Duolingo and Elsa Speak provide instant feedback on pronunciation.

Enhanced Autonomy. Digital tools develop autonomy by helping learners select vocabulary sets, monitor progress, set learning goals, practice independently. This is crucial for intermediate learners transitioning to advanced proficiency.

5. Digital Tools for Productive Vocabulary Use

While many vocabulary applications focus primarily on recognition or receptive knowledge, an equally crucial task for intermediate EFL learners is gaining productive control over new lexical items. Producing vocabulary—using it in writing and speech—requires deeper cognitive

processing, contextual understanding, and repeated activation. Digital tools can scaffold this process by offering structured environments where learners can practice vocabulary in authentic or semi-authentic tasks while receiving feedback, motivation, and opportunities for revision.

5.1. Online Collaborative Writing Platforms

Tools such as Google Docs, Microsoft OneDrive, Etherpad, and classroom-specific platforms (e.g., Moodle Wiki, Padlet, Notion) support real-time collaboration and revision. They enhance vocabulary acquisition through:

- **Contextualized Use.** When students co-write texts, they naturally integrate new words into meaningful contexts, deepening semantic understanding.
- **Peer Feedback.** Students correct or suggest vocabulary to each other, encouraging metalinguistic awareness.
- **Version History.** Learners reflect on earlier drafts, noticing how their vocabulary choices evolved over time.
- **Teacher Modeling.** Teachers can insert synonyms, collocations, or reformulations directly into the shared document.

Research shows that collaborative writing encourages higher lexical density, more advanced vocabulary choices, and more precise lexical selection among intermediate learners.

5.2. Digital Discussion Boards and Voice Tools

Platforms such as Flipgrid, Vocaroo, VoiceThread, and class forums promote vocabulary use in both spoken and written forms:

- Students record short responses using target words.
- They engage in online dialogues, using new vocabulary repeatedly across threads.
- They can rehearse recordings, which reduces anxiety while promoting accuracy.

This contributes to automatization of vocabulary recall, encourages fluency, and integrates both receptive and productive learning.

5.3. AI-Powered Writing Assistants

Tools such as Grammarly, Reverso Context, and integrated writing assistants in LMS systems provide:

- Suggestions for more appropriate vocabulary
- Alerts about misused collocations
- Synonym options with contextual explanations

For intermediate learners, these tools act as scaffolds—not substitutes for thinking—but aids that highlight lexical gaps and support more advanced expression.

However, teachers must guide learners to avoid over-reliance, encouraging them to evaluate suggestions critically rather than accepting them automatically.

6. Challenges and Limitations of Digital Vocabulary Tools

Despite numerous benefits, digital tools also present potential drawbacks. A balanced academic review requires acknowledging these limitations.

Cognitive Overload. Multiple digital platforms may overwhelm learners with notifications, interfaces, and excessive features. When cognitive load increases, vocabulary retention decreases. Teachers should introduce tools slowly, with clear instructions and well-defined goals.

Superficial Engagement. Gamified apps may encourage fast clicking and guessing rather than deep semantic processing. Without teacher-guided reflection, students may treat vocabulary learning as a game rather than an intellectual activity.

Digital Inequality. Not all students have stable access to the internet or modern devices. Teachers must ensure alternative methods or offline versions to maintain equity.

Automated Feedback Limitations. AI tools cannot fully understand context, tone, or pragmatics. Their synonym suggestions may be technically correct but inappropriate. Teacher intervention remains essential.

7. Pedagogical Principles for Effective Integration

Simply adding digital tools to a curriculum does not guarantee learning success. Effective integration requires pedagogical planning. Based on research in CALL (Computer-Assisted Language Learning), several principles emerge.

Purposeful Alignment. Digital vocabulary tasks should align with lesson objectives, learning outcomes, and assessment criteria. Random use of technology reduces efficiency.

Balanced Receptive and Productive Practice. Teachers should combine:

- Recognition tasks (matching, flashcards, quizzes)
- Production tasks (writing, speaking, contextualized use)

This ensures vocabulary is not only memorized, but also used.

Spaced Repetition Scheduling. Tools like Quizlet and Anki should be assigned in coordinated cycles. Research supports 3–5 repetitions across 10–14 days for optimal retention.

Explicit Strategy Instruction. Students should learn digital literacy strategies, such as:

- Evaluating dictionary entries
- Identifying collocational patterns
- Saving lexical notes effectively
- Using online corpora

This promotes autonomy and long-term vocabulary growth.

Continuous Monitoring and Feedback. Vocabulary development must be tracked through: teacher comments, quizzes, portfolio tasks, self-reflection.

Digital tools offer analytics that support this process.

8. Case Studies: Practical Classroom Applications

To demonstrate how digital tools function in real intermediate EFL classrooms, this section presents brief case-based examples.

8.1. Case Study 1: Vocabulary Expansion through Quizlet

In the unit on “Environmental Issues,” the instructor created a Quizlet set of 30 academic terms such as “sustainability,” “renewable resources,” “emissions,” and “biodiversity.” Over a two-week period, students engaged in multiple digital activities designed to reinforce vocabulary: Daily spaced-repetition practice using Quizlet modes such as Learn, Flashcards, and Write, which recycled items at optimized intervals. Collaborative “Quizlet Live” sessions, where learners worked in teams to quickly match terms with definitions, increasing motivation and processing speed. Shared example-building, in which students created original sentences in a Google document and received teacher feedback on contextual accuracy and collocations. Integration into lesson tasks, including discussions and mini-projects requiring the use of target vocabulary.

Outcome: Students demonstrated strong retention, using approximately 80% of the target vocabulary accurately in subsequent written assignments. Analysis showed improved lexical variety, more precise collocation use, and higher confidence in academic vocabulary production.

8.2. Case Study 2: Vocabulary Automatization through Flipgrid

A second intervention used Flipgrid to strengthen oral fluency and automatize vocabulary usage. Each week, students received a list of 10 target words aligned with the class theme. The activities

included: Weekly 1-minute video recordings, in which students incorporated all target words into spontaneous speech on familiar topics. Repeated retrieval, with weekly cycles encouraging the shift from passive recognition to automatic active use. Peer interaction, as students watched classmates' videos, commented on correct usage, and noted pronunciation challenges. Teacher video feedback, offering pronunciation modeling, stress correction, and targeted vocabulary guidance.

Outcome: Students showed notable improvement in pronunciation, rhythm, and lexical fluency. Their spontaneous use of new vocabulary increased, hesitation decreased, and oral performance became more confident and natural. Learners reported that repeated speaking tasks helped them "remember words automatically."

Conclusion

The integration of digital tools into vocabulary instruction for intermediate EFL learners has the capacity to transform vocabulary acquisition for intermediate EFL learners by making it more effective, engaging, and culturally relevant. When integrated strategically within a well-designed pedagogical framework, they enrich students' linguistic competence, promote learner autonomy, and enhance motivation. As global communication increasingly relies on digital literacy, the role of digital tools in vocabulary learning will continue to grow, shaping the future of EFL education. Thus, educators and researchers should continue exploring innovative practices and developing frameworks that maximize the potential of digital technologies while maintaining sound pedagogical principles.

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Gender-inclusive language in foreign language teaching: Relevance, challenges, and pedagogical potential

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Abstract: Amid globalization and increased attention to human rights, gender-inclusive language (GIL) has become an important component of English Language Teaching (ELT). This study explores its role in promoting equality within the Kazakhstani educational context, where gender inequality persists and many ELT materials continue to reflect traditional stereotypes. GIL—including gender-neutral job titles, singular *they*, avoidance of generic masculine forms, and inclusive teacher talk—helps develop relevant linguistic competence, fosters intercultural awareness, and supports a psychologically safe learning environment. Despite these benefits, implementation faces challenges such as limited teacher training, conservative textbooks, and sociocultural resistance. The paper outlines strategies for integrating GIL into ELT, including adapting materials, modeling inclusive discourse, and teaching relevant grammar explicitly. Overall, the integration of GIL is essential for modernizing language education and fostering a culture of equality and respect.

Keywords: gender, gender-inclusive language, ELT, English Language Teaching, communicative competence, language policy, education

In the context of globalization and increased attention to human rights issues, language is no longer viewed solely as a means of transmitting information; it is increasingly understood as a tool for shaping social reality. This is especially relevant in education, where language contributes to the formation of values, behavior patterns, and learners' worldviews. In recent years, special attention has been given to gender-inclusive language as a means of preventing discrimination and fostering a culture of equality. In foreign language teaching (English Language Teaching — ELT), this issue is of particular importance, since students acquire not only grammatical structures and vocabulary but also the cultural norms of the target language community [1].

The relevance of this topic is determined by several factors. First, gender inequality remains a significant social problem, including in Kazakhstan. Second, modern English communication is actively transforming toward inclusivity: neutral forms such as singular *they*, gender-neutral job titles, and inclusive forms of address are increasingly used in official documents, media, and education. Third, most English language textbooks still reflect traditional

gender roles and stereotypes, which necessitates pedagogical reconsideration and adaptation of teaching materials [2].

The main problem lies in the contradiction between modern requirements for inclusive education and real classroom practices in foreign language teaching. On the one hand, society is oriented toward equality and non-discrimination; on the other hand, educational materials and teachers' speech often retain gender stereotypes, the use of generic masculine pronouns, and unequal representation of social roles of men and women. This reduces the educational potential of language instruction and may shape distorted perceptions of social reality among learners.

Gender-Inclusive Language (GIL) refers to a system of linguistic means and communicative strategies aimed at eliminating discrimination based on sex and gender identity. Its main manifestations include:

- the use of gender-neutral job titles (*police officer instead of policeman, firefighter instead of fireman, businessman → businessperson, stewardess → flight attendant, chairman → chairperson / chair*);

- the use of the singular pronoun they;

- avoidance of the generic "he";

- balanced representation of men and women in educational materials;

- gender-neutral teacher talk ("Each student must bring their book") [3].

The Role of Gender-Inclusive Language in ELT:

1. Linguistic Aspect

Modern English is actively developing in the direction of inclusive forms. Their use in the educational process allows students to develop up-to-date language competence that corresponds to real communicative conditions of international interaction [4].

2. Intercultural Communication

Language learning is inseparable from cultural understanding. Gender-inclusive language fosters respect for diversity and prepares learners for interaction in a multinational and multicultural environment.

3. Psychological Safety of Learners

The use of inclusive language contributes to the creation of a comfortable and safe learning environment. Students feel that their identity is respected, which directly affects motivation, classroom participation, and self-confidence.

4. Compliance with Educational Policy

Modern international educational standards are based on the principles of equality and non-discrimination. The implementation of GIL enables educational institutions to comply with these requirements.

Despite its obvious advantages, the implementation of GIL is accompanied by several difficulties:

- insufficient teacher training;

- conservative nature of many teaching materials;

- cultural and sociocultural barriers;

- uncertainty in assessment standards, especially in international examinations [5].

These factors require a systematic and gradual integration of inclusive practices with consideration of national and cultural contexts.

Pedagogical Strategies for Implementing GIL:

1. Modeling inclusive teacher talk:

Each student should submit their assignment on time.

2. Adaptation of teaching materials:

Replacing stereotypical role examples and adding dialogues with balanced gender representation.

3. Development of critical thinking:

Analyzing advertising texts, films, and news from the perspective of gender stereotypes.

4. Explicit grammar instruction:

Teaching singular they, its rules, and contexts of use.

5. Communicative activities:

Role-plays, essays, and business correspondence using gender-neutral forms [6].

In conditions where gender inequality continues to influence the social, economic, and political spheres of Kazakhstan [2], foreign language teaching can become an effective tool for preventing discrimination. Through language, patterns of communication, attitudes toward social roles, and perceptions of equality are formed. Therefore, the integration of GIL into ELT acquires not only linguistic but also significant social value.

Gender-inclusive language in foreign language teaching is an essential tool for fostering a culture of equality, developing intercultural competence, and creating a safe educational environment. Its implementation contributes not only to the modernization of language practices but also to the education of socially responsible and tolerant individuals. Despite existing challenges, the gradual integration of inclusive linguistic forms into ELT is a necessary stage in the modernization of contemporary education.

In conclusion, we would say, that the integration of gender-inclusive language in English Language Teaching is essential for aligning education with contemporary social values and global linguistic trends. By adopting inclusive forms, adapting teaching materials, and promoting critical awareness, educators help create a respectful and equitable learning environment. Although challenges such as limited teacher preparation and culturally ingrained stereotypes persist, systematic implementation of gender-inclusive practices supports both language development and the formation of socially responsible, tolerant learners. Ultimately, gender-inclusive language strengthens the educational process and contributes to the broader goal of promoting equality in Kazakhstani society and beyond.

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THE SIGNIFICANCE OF SELF-ASSESSMENT AND PEER FEEDBACK

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Abstract

This study investigates the role of self-assessment and peer feedback in enhancing students' English language learning within higher education. Using a PRISMA-based systematic review, 393 records from the Scopus database were initially identified, of which 21 empirical studies published between 2020 and 2025 met all inclusion criteria. The search strategy focused on keywords related to self-assessment, peer assessment, learning outcomes, and formative feedback, and was limited to English-language articles in the Social Sciences subject area. The results reveal a significant increase in research activity and citation impact in recent years, demonstrating the growing academic interest in student-centered assessment practices. Bibliometric analyses show that leading contributions originate from the United States, China, the United Kingdom, Australia, Russia, and several emerging regions, including Kazakhstan. The keyword co-occurrence map identifies five major thematic clusters linking self-assessment to peer evaluation, feedback literacy, medical and professional education, metacognition, and self-regulated learning. Overall, the findings indicate that self-assessment and peer feedback foster learner autonomy, metacognitive awareness, evaluative judgment, and improved language performance. However, challenges such as student mistrust in peer competence and difficulties maintaining objectivity highlight the need for structured guidance and instructional support. The study contributes to the expanding body of research advocating for the integration of self-assessment and peer feedback as essential components of effective, reflective, and sustainable higher education pedagogy.

Keywords: self-assessment; peer feedback; peer assessment; metacognition; formative assessment; evaluative judgment; student-centered learning.

Introduction

Research relevance. One of the essential components of the learning process is the evaluation of the learner's acquired knowledge. This raises an important question: *who should conduct the assessment?* If the teacher evaluates students, it becomes an additional task for the teacher. However, if students engage in self-assessment or peer assessment, this process becomes an engaging and meaningful part of their learning experience. Through evaluating themselves or each other, students develop critical thinking skills, which are necessary for analyzing information within their field from a critical perspective. Consequently, a well-designed self-assessment or peer-assessment process undoubtedly yields positive results, as evidenced by numerous studies. The concept of assessment is often interpreted as grading, measuring, or ranking, and therefore peer assessment is frequently perceived as students assigning grades to one another. However, students grading each other should not be limited to merely sharing the teacher's responsibility. Valid assessment is linked to understanding *what* is being assessed and *which tools* are used to ensure accuracy. When questions arise about how grades are assigned, we enter the process of

defining learning outcomes and establishing assessment criteria. Intellectually engaging with outcomes, criteria, and standards lies at the core of student involvement in assessment and leads to a deeper understanding of what constitutes high-quality performance. Encouraging students to reflect on achieving outcomes in accordance with agreed-upon standards is itself a learning process, while assigning a grade or score is only one component of that process. In addition to peer assessment, the concept of peer feedback also plays a crucial role. Peer feedback is a communicative process in which students engage in dialogue about performance quality and standards. Peer assessment, on the other hand, involves students evaluating their peers' work based on defined criteria. The distinction between the two is as follows: peer feedback focuses on detailed, constructive comments without assigning grades, whereas peer assessment is oriented toward grading. Regardless of whether grades are assigned, the primary emphasis is placed on standards and on improving understanding and learning outcomes through peer interaction. The overall purpose of education is to prepare professionals with critical thinking skills capable of processing and synthesizing various types of information in their field.

Research objective. Mastering the English language fluently in a university setting not only improves students' academic performance but also opens significant opportunities for their future careers. One of the important ways to organize the language-learning process effectively is through the use of self-assessment and peer-feedback systems. Therefore, the purpose of this research is to determine the extent to which students can utilize self-assessment and peer feedback. Additionally, the study aims to promote wider implementation of self-assessment and peer feedback practices in the educational system and to integrate effective skills derived from these methods.

Research question: How do self-assessment and peer assessment influence students' mastery of the English language?

Significance of the Study. The significance of this study lies in its contribution to enhancing learner autonomy, critical thinking, and the overall quality of English language acquisition in higher education. In the context of modern pedagogical approaches, self-assessment and peer feedback are recognized as essential components of formative assessment that actively involve students in evaluating their own learning processes. By engaging in these practices, learners develop a deeper understanding of performance standards, become more reflective, and learn to identify strengths and areas for improvement skills that extend beyond language learning and are vital for their future professional development. Furthermore, the study provides empirical insights into how systematically integrating self-assessment and peer feedback can improve learning outcomes, increase motivation, and foster a more collaborative learning environment. Given the growing emphasis on student-centered education and competency-based learning, this research offers valuable guidance for educators, curriculum designers, and higher education institutions seeking to implement more effective and sustainable assessment practices.

Literature Review

Contemporary linguodidactics increasingly focuses on identifying effective strategies for enhancing English language learning in higher education. Among these strategies, self-assessment and peer feedback have emerged as central mechanisms for fostering learner autonomy, critical thinking, and linguistic confidence. These practices shift the emphasis from teacher-centered evaluation toward active student participation, enabling learners to engage more deeply with performance standards and to develop reflective habits essential for academic and professional growth. A growing body of research highlights the role of self-assessment in strengthening students' linguistic confidence and metacognitive awareness. Wang (2025) demonstrates that the use of self-assessment rubrics in academic writing supports students in identifying recurring errors, enhancing their self-regulatory skills, and increasing their confidence in producing English texts. Similarly, Liao (2025), working within a VoiceThread-supported environment, shows that self-

assessment of oral performance contributes to improved speaking proficiency and reduced communication anxiety. These findings underscore self-assessment as a formative tool that enables students to monitor their learning progress and refine their linguistic output more independently. Parallel to this, peer feedback is widely recognized as a powerful interactive process that promotes collaborative learning and deeper engagement with language norms. Zhong (2025), integrating peer feedback within a flipped classroom model, finds that structured peer discussions increase learner motivation and facilitate a clearer understanding of academic standards. In a similar vein, Nam et al. (2025) employ scaffolded peer feedback tasks that guide students through iterative revisions of their written assignments, leading to measurable improvements in text quality. These studies collectively affirm that peer feedback enhances both evaluative judgment and communicative competence. Research at the intersection of peer/self-feedback and digital technologies further expands these pedagogical insights. Zhao (2025) explores the use of online platforms for self-assessment and peer review, illustrating how digital tools not only streamline the feedback process but also contribute to the development of *feedback literacy* students' ability to interpret, evaluate, and apply feedback effectively. Building on this perspective, Zheng, Boud and Dawson (2025) propose an integrated multi-level feedback framework combining self-assessment, peer feedback, and teacher evaluation. Their model provides a comprehensive feedback ecosystem that positions students as active participants in shaping their learning trajectories. Despite the documented benefits, several challenges remain. Wu and Zhang (2025) identify persistent issues related to students' lack of trust in the competence of their peers, which may undermine the credibility of peer-generated feedback. This highlights the necessity of preparing students through explicit instruction on how to deliver constructive, evidence-based commentary. Similarly, Syaifurrokhman (2025) notes that students often struggle with maintaining objectivity in assessment, particularly when linguistic limitations or uncertainty affect their evaluative judgments. These findings suggest that while self-assessment and peer feedback are valuable pedagogical tools, their effectiveness depends on systematic training, teacher mediation, and ongoing quality assurance. The reviewed literature indicates that self-assessment and peer feedback significantly contribute to English language development by enhancing learner autonomy, metacognition, and collaborative engagement. However, for these practices to be fully effective, educators must address the challenges associated with evaluative competence and feedback quality through targeted instruction and supportive learning environments.

In addition to empirical findings, recent scholarship has emphasized the theoretical foundations that explain why self-assessment and peer feedback function effectively in language learning environments. Drawing on Boud's (1995) theory of learner responsibility and Nicol and Macfarlane-Dick's (2006) model of formative feedback, researchers argue that assessment is most impactful when students are positioned as active agents who co-construct meaning, evaluate their progress, and engage with criteria as part of a dialogic process. Carless and Boud (2018) further conceptualize *feedback literacy* as a core graduate capability that enables learners to understand feedback, make informed judgments, and take purposeful action competencies that align closely with the outcomes observed in studies on self- and peer assessment. Additionally, Topping's (2010) framework on peer assessment underscores the crucial social dimension of evaluative practices, emphasizing reciprocal learning, shared standards, and distributed expertise among students. These theoretical perspectives complement the empirical evidence reviewed earlier and highlight that the effectiveness of self-assessment and peer feedback is grounded not only in practical strategies but also in broader pedagogical paradigms that foreground student agency, metacognitive development, and collaborative knowledge construction.

Methods

This study employed a systematic review design following the PRISMA 2020 guidelines to synthesize current research on self-assessment and peer feedback in higher education. The Scopus database was selected as the primary source of data due to its comprehensive indexing of international, peer-reviewed research articles. A structured search strategy was developed using a combination of keywords, Boolean operators, and database filters to ensure the precision and relevance of the retrieved publications. The final search string included the terms “self-assessment,” “students,” “learning,” “self assessment” and “peer assessment” within titles, abstracts, and keywords, and was applied as follows:

TITLE-ABS-KEY ("self-assessment") AND PUBYEAR > 2019 AND PUBYEAR < 2026 AND (LIMIT-TO (SUBJAREA , "SOCJ")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (EXACTKEYWORD , "Self-assessment") OR LIMIT-TO (EXACTKEYWORD , "Students") OR LIMIT-TO (EXACTKEYWORD , "Learning") OR LIMIT-TO (EXACTKEYWORD , "Self Assessment") OR LIMIT-TO (EXACTKEYWORD , "Peer Assessment")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (AFFILCOUNTRY , "United States") OR LIMIT-TO (AFFILCOUNTRY , "Kazakhstan") OR LIMIT-TO (AFFILCOUNTRY , "United Kingdom") OR LIMIT-TO (AFFILCOUNTRY , "Canada") OR LIMIT-TO (AFFILCOUNTRY , "China"))

The search focused exclusively on articles published between 2020 and 2025, written in English, and classified within the field of Social Sciences. The selection process is illustrated in the PRISMA flow diagram presented in Figure 1.

All retrieved records were evaluated in multiple stages to ensure relevance and methodological quality. The initial search identified 393 records, after which duplicates (n = 15),

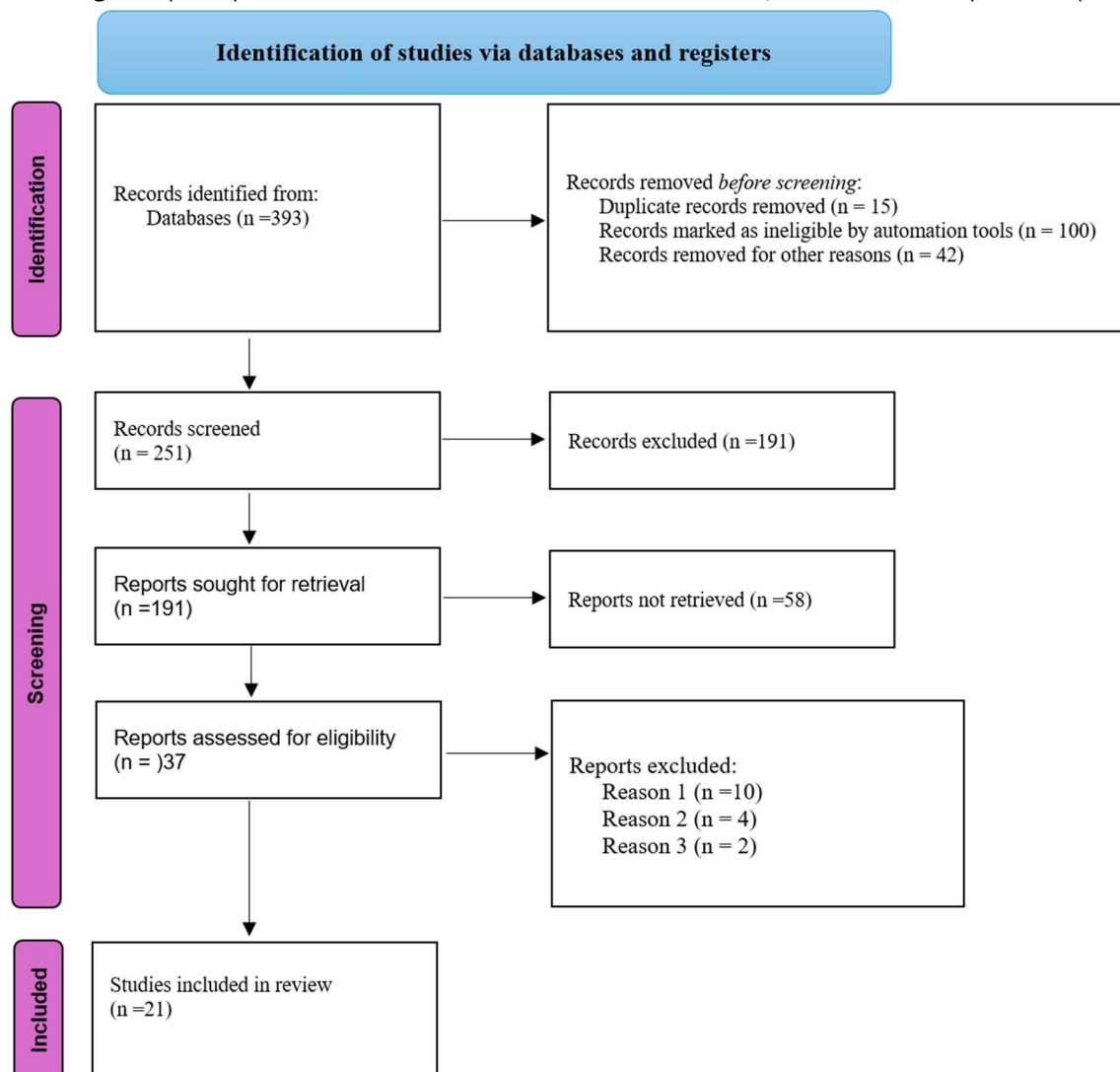


Figure 1. - PRISMA 2020 Flow Diagram for Study Selection

automated exclusions (n = 100), and studies irrelevant by type or preliminary screening (n = 42) were removed. A total of 251 articles proceeded to title and abstract screening, resulting in the exclusion of 191 publications that did not meet the inclusion criteria. Full texts were sought for 191 studies, but 58 could not be retrieved, leaving 37 articles for full-text assessment. These were evaluated against predefined eligibility criteria, which required studies to focus on self-assessment, peer assessment, or peer feedback, include university-level participants, and provide empirical data. Studies were excluded if they did not address assessment practices (n = 10), lacked relevance to self-assessment or peer feedback (n = 4), or fell outside the designated publication period (n = 2). Ultimately, 21 studies met all inclusion criteria and were incorporated into the final analysis. Collectively, these methodological steps ensured a transparent, rigorous, and replicable review process capable of capturing current trends, challenges, and empirical evidence related to self-assessment and peer feedback in modern higher education.

Results

The analysis of publication dynamics demonstrates a sharp and consistent rise in academic interest in self-assessment and peer feedback over the past five years. As illustrated in Figure 2, the number of documents indexed in Scopus surged beginning in 2020, marking a clear turning point in the visibility and relevance of this research topic within the field of higher education. In 2020, publication activity reached its initial peak with more than 70 articles, followed by a continued high output in 2021 and 2022. Although the number of documents shows some fluctuations across the years, the overall trend remains upward, confirming stable research productivity.

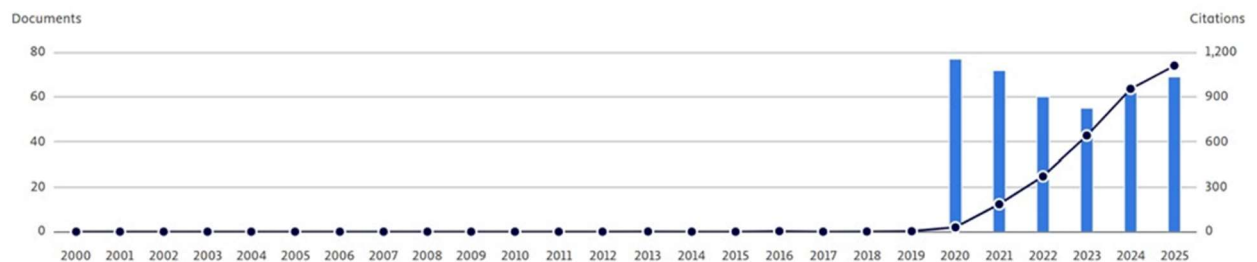


Figure 2. - Annual distribution of publications and citations on self-assessment

Citations exhibit an even more significant and rapid growth trajectory. As shown in Figure 2, citation counts increased almost exponentially from 2020 onward, surpassing 900 citations by 2024 and approaching 1,200 in early 2025. This indicates not only an increase in the volume of research but also its growing scholarly influence and relevance. The continuous citation growth reflects the importance of self-assessment and peer feedback in contemporary pedagogical discourse and suggests that studies published in this period are becoming foundational references for new research in linguodidactics, assessment literacy, and learner autonomy. The pattern of publications and citations confirms that self-assessment has become a rapidly expanding research domain, supported by strong academic engagement and rising citation impact. This underscores the global shift toward student-centered assessment practices and highlights the increasing recognition of feedback literacy and evaluative judgment as essential competences in higher education.

An examination of the geographic distribution of publications reveals that research on self-assessment and peer feedback has gained significant global traction, with notable regional differences in contribution levels. As illustrated in Figure 3, the highest concentration of studies originates from the United States, China, the United Kingdom, Australia, and Russia countries marked in darker blue tones, indicating a high level of research activity. These nations serve as major hubs of academic innovation in assessment literacy, digital pedagogy, and higher education research, thereby shaping international trends in the field. Medium levels of publication activity are observed across a diverse set of countries including Canada, France, Sweden, Kazakhstan, India, Saudi Arabia, Brazil, South Africa, and Indonesia. The presence of these countries demonstrates the widespread and increasing relevance of self-assessment practices beyond traditionally dominant Western scientific communities. Importantly, Kazakhstan appears in the medium research activity category, reflecting the country's growing engagement in global discussions on learner autonomy and contemporary language education.

Furthermore, the expanding global footprint of research on self-assessment and peer feedback reflects broader transformations in higher education systems worldwide. As universities increasingly adopt competency-based curricula, digital learning platforms, and quality assurance frameworks aligned with international standards, the demand for evidence-based assessment practices has intensified. This shift has contributed to a surge of cross-national collaborations,

open-access dissemination, and capacity-building initiatives that support research development in emerging regions. Consequently, self-assessment is not only gaining prominence as a pedagogical technique but is also becoming embedded in institutional policies aimed at fostering lifelong learning, reflective practice, and academic integrity. The emerging participation of countries with limited research infrastructures suggests that global knowledge exchange supported by digital technologies, international partnerships, and multilingual publication practices is gradually reducing geographical disparities in scholarly output. This aligns with current global educational priorities, emphasizing inclusivity, transparency, and learner-centered pedagogy as foundational

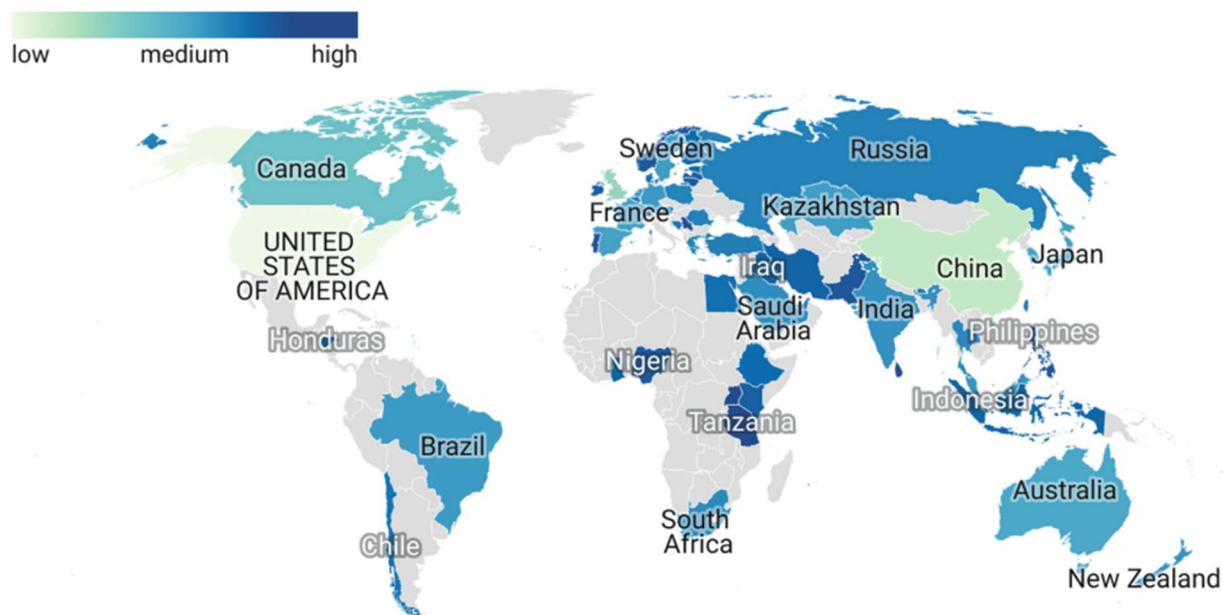


Figure 3. - Global geographic distribution of research on self-assessment

principles for sustainable academic innovation.

In contrast, regions shown in lighter shades such as Chile, Honduras, Tanzania, and Nigeria demonstrate lower levels of publication output, although their inclusion signifies emerging scholarly interest. The geographical expansion of research into countries with developing research infrastructures suggests a broadening recognition of self-assessment as a critical pedagogical tool adaptable to diverse socio-educational contexts. Taken together, the global distribution patterns presented in Figure 3 underscore the internationalization of research on self-assessment. The presence of both high-output and emerging countries demonstrates that the topic has become a widely shared academic priority, influenced by global educational reforms, shifts toward student-centered learning, and the integration of digital tools that facilitate peer evaluation and self-reflection.

The keyword co-occurrence analysis provides deeper insight into the conceptual structure of contemporary research on self-assessment. As shown in Figure 4, the central position of *self-assessment* indicates its strong interconnectedness with multiple thematic clusters, demonstrating that the field is multidisciplinary and methodologically diverse. The size of the node reflects its frequency across publications, confirming that self-assessment serves as the primary focal point in the literature. This centrality also suggests that self-assessment operates as an anchoring construct that links pedagogical theories with practical classroom applications across various disciplines. The close proximity of terms such as *peer assessment*, *feedback*, *evaluation*, and *learning outcomes* highlights the integrative nature of assessment practices, where self-regulation, reflective judgment, and collaborative evaluation form a cohesive ecosystem. Moreover, the presence of

keywords related to digital learning environments indicates that technological innovation is increasingly shaping how students engage with assessment processes. The interconnection between cognitive, social, and technological dimensions within the network map reflects the evolving complexity of assessment literacy in modern education. Collectively, these patterns illustrate that self-assessment research is expanding beyond isolated skill development toward a broader framework that encompasses metacognition, digital pedagogy, and student-centered learning.

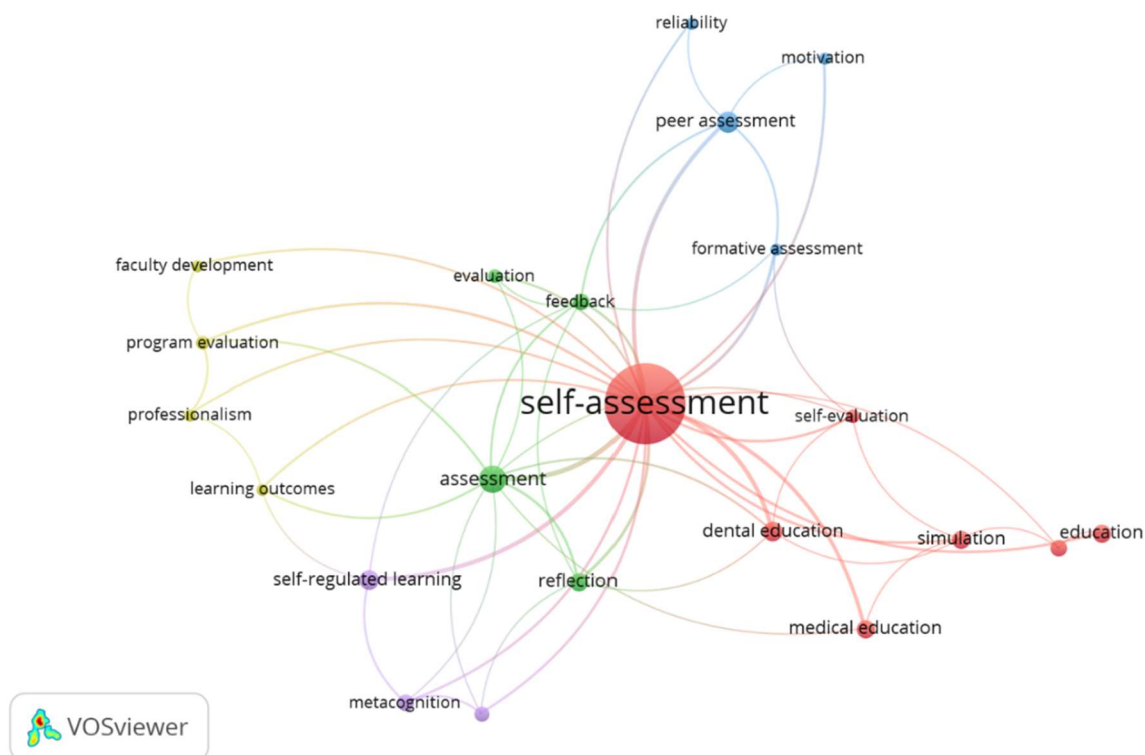


Figure 4. - Keyword co-occurrence network map for self-assessment research

The red cluster highlights the integration of self-assessment within professional and medical education, including terms such as *medical education*, *dental education*, and *simulation*. This indicates that health-related disciplines represent a major application area where self-assessment is used to develop clinical competence, reflective practice, and procedural accuracy. The growing emphasis on simulation-based training suggests that self-assessment plays a crucial role in ensuring the quality of experiential learning.

The blue cluster centers on peer assessment and formative assessment, connecting nodes like *peer assessment*, *formative assessment*, *motivation*, and *reliability*. This cluster underscores the complementary relationship between self- and peer-based evaluation practices, highlighting the importance of feedback cycles, the development of evaluative judgment, and student motivation. These findings align with pedagogical models emphasizing learner agency and collaborative learning.

The green cluster represents feedback, evaluation, and learning outcomes, showing how self-assessment is embedded in broader assessment frameworks. The presence of terms such as *feedback*, *evaluation*, and *assessment* suggests that self-assessment is not an isolated skill but part of a larger instructional process that aims to improve learning outcomes and assessment literacy.

The yellow cluster emphasizes professionalism, program evaluation, and faculty development, pointing to institutional and curricular dimensions of assessment practices. This

indicates that the implementation of self-assessment is increasingly viewed as a systemic educational innovation rather than a classroom technique alone.

The purple cluster includes terms linked to metacognition and self-regulated learning, demonstrating the cognitive and psychological foundations of self-assessment. The association with metacognitive processes reinforces the idea that self-assessment contributes to deeper learning, reflective thinking, and long-term learner autonomy.

The network visualization in Figure 4 reveals that self-assessment research spans several interconnected domains pedagogical, cognitive, technological, and professional. This diversity reflects the field's evolution toward a comprehensive understanding of how self-evaluative practices support student development across disciplinary and educational contexts.

Discussion

The systematic review provides strong and consistent evidence that self-assessment and peer feedback play a crucial role in enhancing students' autonomy, metacognitive awareness, and overall language competence. Across the 21 studies included in the review, scholars consistently highlight that self-assessment enables learners to monitor their progress, identify strengths and weaknesses, and engage more deeply with the learning process (Wang, 2025; Liao, 2025). This finding aligns with Klenowski's (1995) definition of self-assessment as a reflective practice aimed at improving learning outcomes. The review also demonstrates that peer feedback serves as an essential interpersonal mechanism for promoting formative learning interactions. Studies conducted in various instructional formats including flipped classrooms, digital learning environments, and scaffolded writing activities show that peer feedback contributes to increased motivation, stronger evaluative judgment, and more effective revision strategies (Zhong, 2025; Nam et al., 2025). These observations reinforce Liu and Carless's (2006) argument that student engagement with assessment criteria and standards is key to producing high-quality academic work. Furthermore, the bibliometric trends indicate a dramatic rise in research activity and citation impact between 2020 and 2025, confirming that self-assessment has become a rapidly expanding field of inquiry. As illustrated in Figure 2, this upward trajectory reflects the growing global interest in student-centered assessment practices. Geographical distribution analysis (Figure 3) shows that contributions come from both established research centers such as the United States, China, the United Kingdom, Australia, and Russia and emerging academic contexts, including Kazakhstan, Saudi Arabia, Brazil, and South Africa. This demonstrates that the discourse on self-assessment is increasingly international and diverse. The keyword co-occurrence network (Figure 4) reveals five large thematic clusters that connect self-assessment to medical education, peer assessment, learning outcomes, professionalism, and metacognition. This confirms that self-assessment is not confined to language learning but extends into broader pedagogical and professional domains (Boud, 1995; Zheng, Boud & Dawson, 2025). Importantly, several studies also highlight the persisting challenges related to student mistrust in peer evaluative competence, difficulties maintaining objectivity, and the need for explicit instruction in giving and interpreting feedback (Wu & Zhang, 2025; Syaifurrokhman, 2025). These limitations indicate that self-assessment and peer feedback must be deliberately scaffolded and supported by educators.

Conclusion

This study contributes to a growing body of evidence demonstrating that self-assessment and peer feedback are essential components of effective, student-centered learning environments in higher education. Through a systematic review of 21 empirical studies published between 2020 and 2025, the research confirms that these practices enhance learners' autonomy, metacognitive skills, motivation, and language proficiency. The bibliometric analysis further reveals the rapid expansion and increasing scholarly impact of research in this area, supported by global participation across diverse educational contexts. The conceptual patterns identified in the keyword network analysis illustrate that self-assessment intersects with several critical domains,

including formative assessment, feedback literacy, professional education, and self-regulated learning. These insights underscore the multidimensional nature of self-assessment and highlight its relevance for preparing reflective, competent, and independent learners capable of managing their own progress. Despite the considerable benefits, the review also identifies challenges that require attention particularly the need for improved training in evaluative judgment, clearer assessment criteria, and enhanced support for peer feedback processes. Addressing these challenges will strengthen the reliability and impact of self-assessment practices. In conclusion, self-assessment and peer feedback represent powerful pedagogical tools that, when properly implemented, contribute significantly to the development of high-quality learning outcomes. Their integration into higher education curricula should therefore be considered not merely an instructional technique but a strategic investment in fostering lifelong learning, reflective practice, and academic excellence.

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RESEARCHING THE COGNITIVE PROCESSES OF PRESCHOOL CHILDREN THROUGH “INTELLECTUM” LOGICAL GAMES

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Abstract

This study investigates the role of “Intellectum” logical games in developing the cognitive processes of preschool children. Using a systematic review and bibliometric analysis of 177 peer-reviewed articles from the Scopus database (2004–2025), the research identifies key thematic trends in early cognitive development, emphasizing attention, memory, imagination, perception, and logical reasoning. PRISMA methodology guided the selection of sources, while VOSviewer and Bibliometrix software were used to generate keyword co-occurrence maps and thematic clusters. The results show a steady growth in scholarly interest in children’s cognitive development, particularly in relation to game-based learning and digital tools. Five major research clusters were identified: core cognitive processes and school readiness; family environment and behavioral regulation; language development; socioeconomic determinants; and longitudinal developmental trajectories. The findings align with classical theories by Vygotsky and Piaget, demonstrating that structured logical games serve as effective mediating tools that scaffold children’s cognitive engagement. The study concludes that “Intellectum” logical games are a developmentally appropriate and evidence-based method for enhancing preschool children’s cognitive competencies and improving their readiness for formal schooling.

Keywords: Cognitive processes, logical games, preschool group, Intellectum, developmental game, attention.

Introduction

Relevance of the research. In contemporary educational practice, the preschool period is widely recognized as a crucial stage in a child’s intellectual, emotional, and social development. From an early age, children’s interaction with their environment shapes the formation and growth of key cognitive processes thinking, imagination, memory, perception, and attention all of which form the foundation of their psychological development. The level at which these cognitive abilities develop directly influences a child’s preparedness for formal schooling, their capacity to assimilate new information, articulate ideas, and engage in problem-solving (Umurqulova, 2025). Within the current educational system, one of the central priorities of preschool education is the early development of children’s cognitive abilities. Play is the child’s natural mode of activity and serves as a fundamental mechanism for personal and intellectual development. It integrates internal and external actions and unites cognition with emotion (G’aniyeva, 2025). In this context, “*Intellectum*” logical games constitute a modern pedagogical tool that enhances memory, stimulates imagination and logical reasoning, and strengthens overall cognitive engagement. According to Piaget’s developmental theory, a child’s thinking evolves in sequential stages, making age-appropriate

cognitive stimulation essential. The integration of innovative game-based technologies into the educational process has therefore become an urgent need, ensuring the development of individual abilities and improving school readiness. Through logical games, children learn to compare objects and phenomena, identify relationships, and make conclusions (Panhelova, 2020). Cognitive development is inherently tied to learning through experience, and play serves as a primary medium through which children acquire that experiential understanding. Furthermore, preschool education ensures the use of diverse pedagogical methods aimed at supporting a child's holistic development.

Research aim. To theoretically substantiate the use of “*Intellectum*” logical games in developing cognitive processes among preschool children and to design a methodological system for their implementation, validating its effectiveness through experimental work.

Research question: What logical games are used in preschool institutions with preparatory groups, and how do these games influence the cognitive development of children?

The theoretical basis of this study draws on scientific literature addressing cognitive development and logical games in early childhood, particularly the works of L. S. Vygotsky, J. Piaget, D. B. Elkonin, and A. Leontiev, who extensively studied cognitive growth and play-based learning. The methodological framework includes the selection of relevant literature using keyword searches in Scopus, systematic article selection following PRISMA guidelines, and bibliometric analyses conducted through VOSviewer and Bibliometrix software.

Object of the research is cognitive processes of preschool children in preparatory groups. *The subject of the research* is the process of developing cognitive processes through “*Intellectum*” logical games in preschool educational settings.

Significance of the study. This study holds both theoretical and practical significance for the field of preschool education and cognitive developmental psychology. Theoretically, it contributes to a deeper understanding of how game-based learning tools specifically “*Intellectum*” logical games support the development of key cognitive processes such as attention, perception, memory, imagination, and logical reasoning in preschool-aged children. By integrating classical developmental theories with contemporary approaches to innovative educational technologies, the research expands existing knowledge on the mechanisms through which structured logical games enhance cognitive growth. Practically, the findings provide educators, curriculum developers, and preschool organizations with an evidence-based methodological system for using “*Intellectum*” logical games to improve children's readiness for school. The study helps identify effective strategies for designing educational environments that foster cognitive engagement, problem-solving skills, and independent thinking. Demonstrating the effectiveness of logical games in real classroom conditions, the research offers actionable recommendations that can be incorporated into early childhood education programs, thereby promoting children's intellectual development and supporting national priorities for improving the quality of preschool education.

Literature Review

The intersection of early childhood education and digital technology has received significant scholarly attention, particularly regarding its impact on cognitive development, executive functioning, and learning outcomes. Multiple empirical and theoretical works suggest both benefits and limitations of technology use among preschool-aged children. One foundational work in cognitive development, Vygotsky (1978), emphasized the sociocultural nature of learning, highlighting the role of tools (including, arguably, digital ones) in mediating mental functions. He introduced the concept of the Zone of Proximal Development (ZPD), which has since been used to justify scaffolded digital learning environments. Similarly, Piaget's (1952; 1972) stage theory of cognitive development offers a framework for understanding how children might engage with digital content based on their developmental stage, such as sensorimotor or preoperational thought. In the context of executive functioning, Carlson and Meltzoff (2008) provided strong

evidence that bilingual experience enhances executive function in young children, including inhibitory control and cognitive flexibility. These findings are significant when considering the use of interactive media and bilingual apps, which may provide comparable cognitive stimulation. Their research implies that certain types of complex cognitive activity like navigating dual-language environments or problem-solving through apps could benefit executive development. From a practical perspective, Plowman and McPake (2013) challenged several widespread myths about children and technology, arguing that concerns over “digital harm” often lack empirical support. Their study demonstrated that children's interactions with technology are highly context-dependent, and emphasized the importance of adult mediation rather than complete restriction. They caution against oversimplifying digital engagement as universally harmful or beneficial.

Adding further nuance, Davidson (2014) explored multimedia engagement among preschoolers and found that active multimedia environments can enhance cognitive responses when designed to match children's attention spans and developmental needs. The study emphasizes the importance of interactive and age-appropriate digital design, echoing concerns from both Piagetian and Vygotskian perspectives about matching content to developmental readiness. Looking into systemic integration of digital tools, Zheng et al. (2016) conducted a meta-analysis of one-to-one laptop environments in K-12 education. Though focusing on older children, the findings revealed positive effects on writing, science, and English learning, suggesting that early digital exposure may prepare children for future academic integration of technology. The review emphasized the importance of teacher training and pedagogical strategies alongside digital adoption. In a broader critique of edtech enthusiasm, Cuban (2001) argued that computers in classrooms have been oversold and underused, with minimal change in actual pedagogy. This work serves as a caution against assuming that technology alone drives cognitive development, reinforcing the need for educational intentionality in tech use. Lastly, Miller (2012) examined how media adaptations of fairy tales impact children's perception of traditional literature. The findings suggest that while screen media can enhance imaginative engagement, they may also alter narrative interpretation. This points to the need for balancing literary and multimedia experiences in early learning to foster comprehensive cognitive and linguistic development.

Beyond digital media more broadly, recent research has increasingly highlighted the role of structured educational games both digital and non-digital in supporting children's cognitive growth. Studies on game-based learning environments indicate that logical, rule-based, and problem-solving tasks can significantly enhance children's attention control, working memory, and reasoning abilities, all of which are foundational components of executive functioning. For example, G'aniyeva (2025) and Umurqulova (2025) demonstrated that preschoolers who consistently engage in structured logical games show measurable improvements in classification skills, spatial reasoning, and the ability to identify patterns and relationships. These findings reinforce the argument that cognitive engagement is strongest when learning activities are interactive, developmentally appropriate, and scaffolded within meaningful contexts characteristics shared by many educational game platforms, including “Intellectum.” Such research suggests that logical games may serve as an effective bridge between traditional hands-on pedagogical tools and emerging educational technologies, offering a balanced approach that stimulates cognitive processes while remaining grounded in age-appropriate play.

Methods

This study employed a systematic review and bibliometric analysis to investigate the role of logical games specifically “*Intellectum*” in supporting the cognitive development of preschool children. The methodological procedure followed the PRISMA guidelines to ensure transparency, replicability, and accuracy in the selection of scientific publications. The data for the review were obtained from the Scopus database, which provides a comprehensive collection of peer-reviewed

articles in psychology, education, and social sciences. The search was conducted using the following query:

TITLE-ABS-KEY ("children's cognitive development") AND PUBYEAR > 2003 AND PUBYEAR < 2026 AND (LIMIT-TO (SUBJAREA , "PSYC") OR LIMIT-TO (SUBJAREA , "SOCI")) AND (LIMIT-TO (EXACTKEYWORD , "Cognitive Development") OR LIMIT-TO (EXACTKEYWORD , "Preschool Child") OR LIMIT-TO (EXACTKEYWORD , "Child Development")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (DOCTYPE , "ar"))

This strategy ensured the inclusion of studies specifically focused on cognitive development in preschool-aged children, published in English between 2004 and 2025, and indexed in relevant subject areas. The PRISMA flowchart (Figure 1) illustrates the multistage screening and selection procedure. In total, 1,032 records were initially identified. After automated filtering of ineligible items (n = 735), 297 studies remained for manual screening. No records were excluded at the screening stage. Full-text retrieval was attempted for all 297 studies, but 21 records could not be accessed. The remaining 276 articles were assessed for eligibility based on predefined criteria, including research focus on preschool children aged 3–6, examination of cognitive processes (attention, perception, memory, thinking, imagination), relevance to game-based or logical learning methods, and publication in peer-reviewed journals. Following eligibility assessment, 99 studies were excluded due to thematic irrelevance (Reason 1, n = 42) or insufficient methodological rigor (Reason 2, n = 57). Ultimately, 177 studies met all selection criteria and were included in the final review.

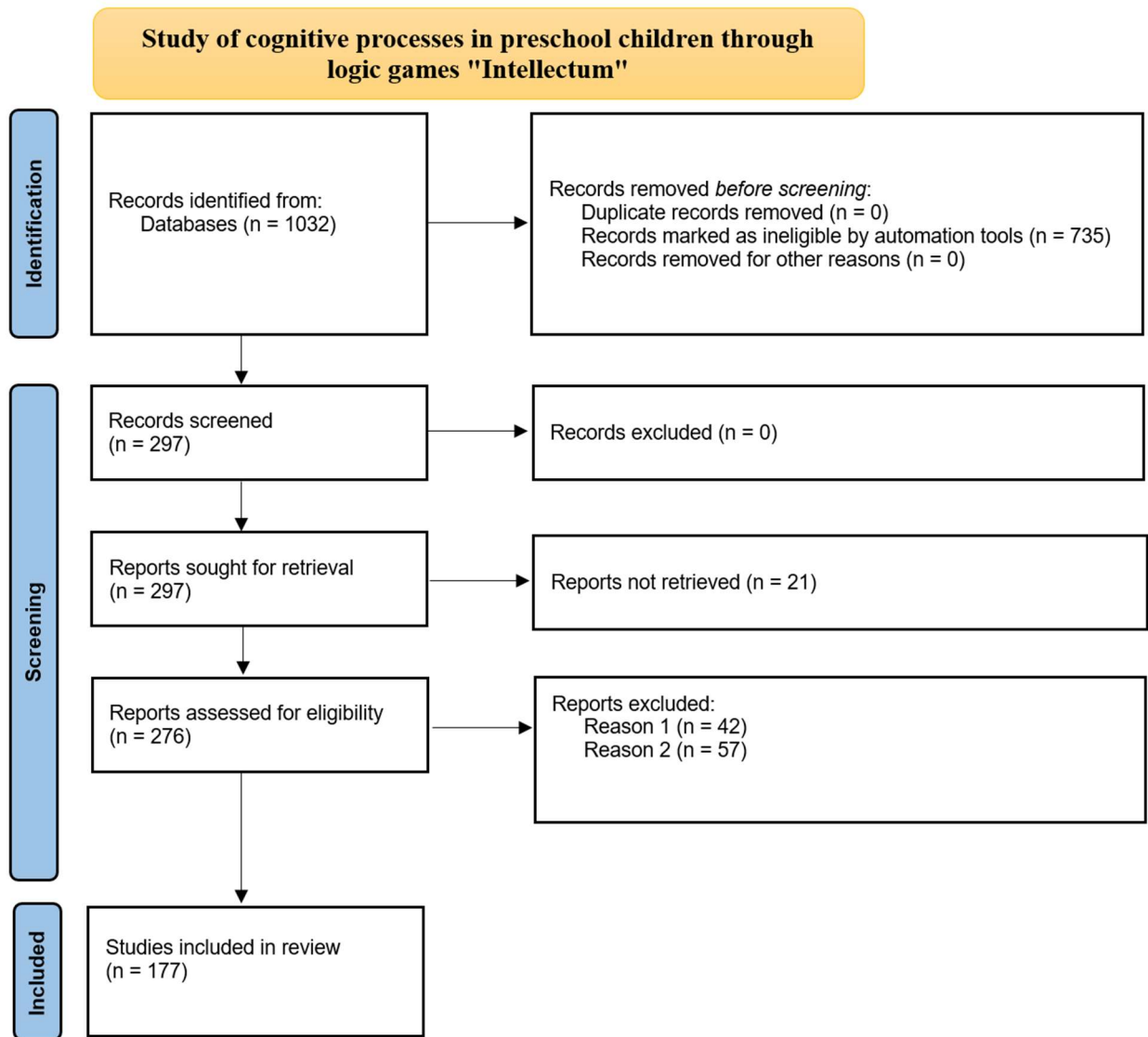


Figure 1. - PRISMA flowchart illustrating the screening and selection of studies

To analyze the selected publications, a combination of bibliometric and qualitative techniques was employed. VOSviewer software was used to generate keyword co-occurrence networks and thematic clusters, enabling identification of dominant research directions in the field of preschool cognitive development. Qualitative synthesis further examined how logical and developmental games contribute to enhancing cognitive processes such as memory, attention, imagination, and logical reasoning in preschool children. This comprehensive methodological approach ensured a robust analysis of current scientific evidence on the effectiveness of logical game-based educational tools in early childhood learning.

Results

Publication dynamics. The analysis of publication activity over the period from 2000 to 2025 shows a clear and steady upward trend in research related to children’s cognitive development. During the early 2000s, scholarly output in this field remained minimal, with only isolated publications appearing between 2000 and 2006. A noticeable increase begins around 2008-2010, when researchers started paying greater attention to early childhood cognitive processes, likely due to the growing integration of developmental psychology and educational innovation. From 2012 onward, the number of publications began to rise more consistently, reflecting an expanding interest in early childhood learning, cognitive stimulation, and the role of structured educational

activities. A particularly sharp growth is observed after 2016, when annual output increased significantly, indicating that this research area had become more established within the scientific community. The years 2018–2024 represent the most productive period, marked by a substantial rise in both publications and citations. This growth corresponds with the global surge in studies on game-based learning, digital tools, and cognitive development in preschool education. Citation patterns demonstrate a similar trajectory. Citations remained low in the early 2000s, gradually increasing in parallel with the rise in publications. A major shift occurs after 2015, when citation numbers begin to grow rapidly, reflecting heightened academic interest and the accumulation of foundational research in the field. Peak citation activity is recorded between 2022 and 2024, confirming that recent publications have gained strong scientific visibility and impact. The steady increase in both publications and citations indicates that research on children’s cognitive development has evolved from a niche topic into a well-established interdisciplinary field integrating psychology, pedagogy, neuroscience, and innovative educational technologies. The growth trend suggests sustained long-term relevance and expanding scholarly engagement with methods that enhance early cognitive skills, including the use of logical and developmental games.

The bibliometric mapping of keywords reveals several interconnected thematic clusters that structure contemporary research on cognitive development in preschool children. The network is centered around the core concepts “*cognitive development*” and “*child development*,” which serve as bridging nodes linking multiple specialized research directions. The visualization demonstrates how different domains such as learning processes, family environment, behavioral factors, and school readiness collectively contribute to the broader understanding of early cognitive growth. As illustrated in Figure 2, the bibliometric mapping of keywords reveals a complex structure of interconnected thematic clusters that shape contemporary research on cognitive development in preschool children.

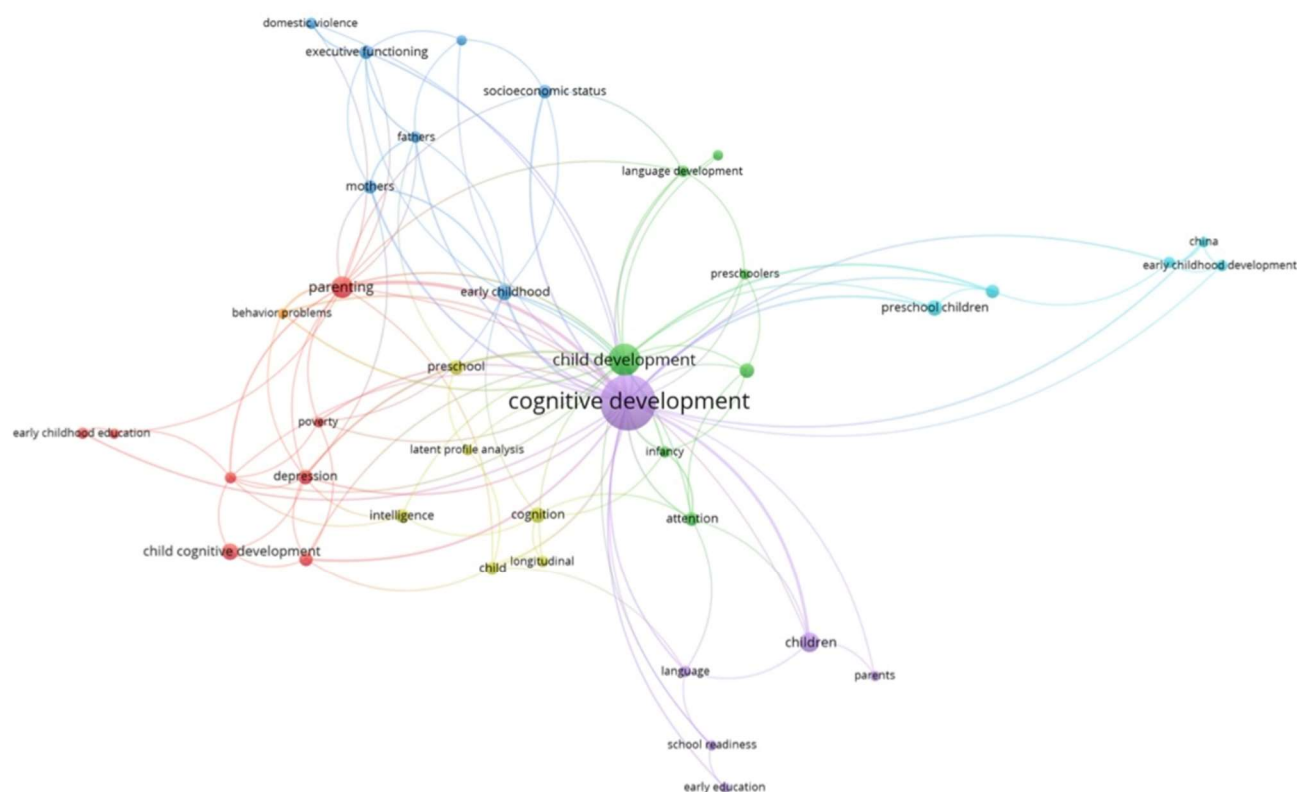


Figure 2. - Keyword co-occurrence network on cognitive development research

Cluster 1. Core cognitive processes and school readiness (central purple cluster). This cluster represents the conceptual nucleus of the entire network, as it includes the highest-frequency

keywords: *cognitive development, child development, attention, memory, school readiness, and early education*. Research in this domain primarily focuses on fundamental cognitive functions such as working memory, attentional control, perception, and basic reasoning that are foundational to children's learning trajectories. Studies consistently show that well-developed cognitive processes in early childhood strongly predict literacy, numeracy, executive functioning, and long-term academic outcomes. The inclusion of terms related to *school readiness* indicates the field's growing emphasis on preparing children for successful transitions into formal schooling. Overall, this cluster serves as the theoretical backbone linking all other thematic areas.

Cluster 2. Parenting, home environment, and behavioral regulation (red cluster). The red cluster highlights the substantial influence of family dynamics on children's cognitive development. Keywords such as *parenting, behavior problems, early childhood, child cognitive development, and developmental outcomes* reveal a research focus on the home environment as a critical developmental context. Studies within this cluster explore how parental warmth, responsiveness, involvement in learning, and disciplinary strategies shape children's cognitive and emotional regulation. Research also investigates how behavioral challenges such as aggression, attention difficulties, or emotional dysregulation interact with cognitive processes. This cluster demonstrates that cognitive development cannot be understood without examining the socio-emotional climate in which children grow.

Cluster 3. Language development and communication skills (green cluster). This cluster is built around keywords such as *language development, preschoolers, preschool children, and early childhood education*. It reflects the central role of language as both a cognitive tool and a developmental outcome. Research in this area analyzes how vocabulary growth, narrative abilities, early verbal interaction, and exposure to rich linguistic environments contribute to broader cognitive functions, including imagination, logical reasoning, and socio-emotional understanding. The strong connections between language-related keywords and the central concept of *cognitive development* indicate that linguistic competence is one of the most significant predictors of intellectual growth in preschool-aged children.

Cluster 4. Socioeconomic determinants and environmental context (blue cluster). This cluster includes concepts such as *socioeconomic status, mother, executive functioning, home environment, and resources*. It captures research that explores how broader structural and environmental conditions influence children's cognitive development. Studies consistently show that socioeconomic disparities affect access to stimulating materials, early learning opportunities, and high-quality educational environments. Maternal education, parental stress, and home learning activities are also frequently examined as mediators. The cluster highlights how cognitive development is shaped by both immediate family resources and broader social inequalities, emphasizing the importance of equity in early childhood education.

Cluster 5. Intelligence, developmental trajectories, and longitudinal approaches (yellow cluster). The yellow cluster is characterized by terms such as *intelligence, longitudinal, latent profile analysis, cognitive growth, and development*. This domain reflects methodological sophistication and focuses on the long-term trajectories of cognitive skills. Studies in this cluster often employ longitudinal designs to trace the stability and change of cognitive abilities over time. Researchers use advanced statistical models to identify developmental profiles, risk factors, and predictors of cognitive performance. This cluster highlights the increasing emphasis on understanding how children's cognitive skills evolve rather than examining them at a single time point.

These clusters demonstrate that contemporary research on cognitive development in preschool children is inherently multidimensional, reflecting the complexity of early learning processes. Rather than viewing cognitive development as a purely internal or biologically

predetermined phenomenon, current scholarship emphasizes its dynamic and interactive nature. Cognitive growth emerges from the continuous interplay of several key domains: individual cognitive abilities such as attention, memory, and reasoning; linguistic development, which supports symbolic thinking and communication; and the family environment, which provides emotional security, guided participation, and early learning opportunities. Socioeconomic conditions further shape children's access to resources, educational experiences, and stimulating environments, creating disparities that influence developmental trajectories from an early age. Additionally, longitudinal research underscores the importance of developmental timing and continuity, showing that early cognitive advantages or constraints often persist and evolve across childhood.

Discussion

The findings of this study provide a comprehensive understanding of how cognitive development in preschool children is shaped through multiple interrelated dimensions, including core cognitive functions, family influences, language development, socioeconomic conditions, and long-term developmental trajectories. The bibliometric analysis demonstrated that research in this field has grown steadily over the past two decades, reflecting increasing scholarly interest in early cognitive stimulation and the use of structured educational tools such as logical games. These results align closely with existing theoretical and empirical literature on early childhood development. First, the prominence of core cognitive functions attention, memory, perception, working memory, and early reasoning confirms long-standing developmental theories. Piaget's (1972) stage theory posits that children in the preoperational stage rely heavily on symbolic, visual, and hands-on tasks, which corresponds directly with the design principles of *Intellectum* logical games. These games emphasize comparison, pattern recognition, sequencing, and problem-solving, all of which engage the cognitive structures Piaget described. Similarly, Vygotsky's (1978) sociocultural theory highlights the role of mediated activity in cognitive development. Logical games act as such mediators, providing scaffolding that allows children to operate within their Zone of Proximal Development (ZPD), a concept widely supported in the literature on educational and digital learning environments. Second, the strong emphasis on family dynamics identified in Cluster 2 reinforces research showing that cognitive development emerges within a broader social and emotional context. Studies by Carlson and Meltzoff (2008) and Plowman and McPake (2013) underscore the importance of adult mediation, responsive interaction, and emotionally supportive environments in shaping executive functioning and cognitive growth. These insights extend to the use of logical games: parental involvement and teacher facilitation enhance children's engagement, attention regulation, and understanding of game-based tasks. The Results therefore echo prior research indicating that learning tools alone are insufficient without meaningful social interaction and guidance. Third, the central role of language development within the research landscape confirms extensive literature identifying linguistic abilities as predictors of broader cognitive outcomes. Davidson (2014) and Miller (2012) highlight how multimedia and verbal engagement support imagination, narrative development, and symbolic thinking. The close link between language and cognitive development in the clusters suggests that activities such as logical games which often require verbal explanation, rule comprehension, and classification can reinforce both linguistic and cognitive skills simultaneously.

Fourth, the influence of socioeconomic and environmental conditions, as revealed in Cluster 4, aligns with long-standing evidence that disparities in resources, parental education, and home learning environments substantially shape cognitive outcomes in early childhood. Research by Zheng et al. (2016) and Cuban (2001) highlights that the successful integration of learning tools depends heavily on instructional quality, availability of resources, and teacher readiness. This suggests that the effectiveness of *Intellectum* games may vary across different institutional contexts and underscores the need for equitable access to high-quality early childhood materials.

Lastly, the growing body of longitudinal and methodologically sophisticated research identified in Cluster 5 reflects an important shift in the field toward understanding cognitive development as a dynamic process rather than a static set of abilities. Studies such as Panhelova et al. (2020) confirm that sustained cognitive engagement particularly through structured activities such as motor-integrated or game-based tasks contributes to stable developmental progress over time. This finding strongly supports the rationale for incorporating structured logical games in preschool curricula as consistent, developmentally aligned activities. The discussion of results demonstrates that the use of “*Intellectum*” logical games aligns not only with contemporary educational practices but also with the theoretical foundations laid by Piaget, Vygotsky, and modern empirical research. Logical games support attention regulation, memory retention, symbolic reasoning, and problem-solving abilities consistently identified in the literature as core predictors of school readiness and long-term academic success. By integrating cognitive stimulation with playful, scaffolded, and socially mediated activities, these games represent a developmentally appropriate and evidence-based approach to strengthening preschool children's cognitive competencies.

Conclusion

The present study provides a comprehensive theoretical and bibliometric examination of how “*Intellectum*” logical games support the cognitive development of preschool children. The systematic review of 177 scientific articles and the keyword-based cluster analysis demonstrated that early cognitive development is a multidimensional process shaped by core mental functions, language proficiency, family environment, socioeconomic conditions, and long-term developmental trajectories. Within this landscape, logical and game-based learning tools consistently emerge as effective pedagogical strategies for strengthening children’s cognitive engagement, attention regulation, memory, imagination, and problem-solving abilities. The findings align closely with classical developmental theories. Piaget’s conceptualization of the preoperational stage and Vygotsky’s view of mediated learning through the Zone of Proximal Development provide strong theoretical justification for integrating structured logical games into preschool curricula. Empirical studies also support the conclusion that game-based and interactive learning environments promote higher executive functioning, narrative thinking, and symbolic reasoning. The clusters identified in the bibliometric analysis further confirm that cognitive development cannot be viewed in isolation; instead, it results from the interplay of social, linguistic, behavioral, and environmental factors. Overall, the research suggests that “*Intellectum*” logical games represent a developmentally appropriate and pedagogically effective tool for enhancing children’s cognitive competencies and improving their readiness for school. Their use aligns with contemporary educational priorities aimed at fostering holistic development, encouraging independent thinking, and creating rich learning environments. Future research may expand on this work by examining the empirical impact of *Intellectum* games through experimental designs, cross-cultural comparisons, or direct classroom observations.

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Digital Tools in ESP Teaching: Benefits and Limitations in the Educational Context

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Abstract

With the rapid development of technology and the widespread digitalization of key areas of modern life, not only the ways and channels of obtaining information are changing, but also the nature and organization of educational processes. The transition from traditional, established forms of education to hybrid (mixed) and fully electronic (digital) models has become an integral, mandatory part of the development strategies of the higher education system in many countries of the world. As a result of this profound transformation, digital tools have ceased to be secondary, auxiliary resources and have become a full-fledged, fundamental component of the learning environment, which directly affects the content of subjects taught, teaching methods, ways of interaction between participants in the process and forms of evaluation of achieved results. This transformation is particularly evident in the field of foreign language teaching, where the modern digital environment provides a unique opportunity to create authentic, real-life communication situations, simulate professionally meaningful dialogues, and provide students with prompt access to materials that reflect the actual, relevant requirements of the global labor market.

Key words: technology, digital, transformation, foreign language.

INTRODUCTION

Digital technologies acquire the greatest importance and relevance in teaching English for Specific Purposes (ESP), since this discipline is purposefully focused on the formation of linguistic skills that are directly related to the future professional activities of students. Unlike the general (general education) English course, ESP places significant emphasis on terminological accuracy, a detailed understanding of specialized texts, the ability to conduct professional communication in accordance with industry standards, and the ability to use a foreign language as a key tool for solving specific professional tasks. In order to effectively ensure such a narrow, practice-oriented focus, the teacher needs to systematically access the most relevant authentic materials, maintain close contact with current industry standards and create conditions favorable for practice-oriented, applied interaction. Digital tools, ranging from modern platforms for distance learning to complex simulations of professional situations and technologies based on artificial intelligence, open up the widest possible opportunities for the successful implementation of all these complex tasks [2].

However, along with a significant expansion of pedagogical and methodological capabilities, certain limitations arise that require careful, critical analysis. Practical experience shows that access to advanced digital resources is often unevenly distributed among students, and not all students have the necessary and sufficient level of digital literacy. Teachers, in turn,

face methodological difficulties in integrating completely new tools and technologies into established curricula, and excessive automation of some aspects of the educational process can often lead to an undesirable decrease in students' independence and initiative. In this regard, it becomes critically important to assess not only the obvious potential and possibilities of digital technologies, but also their complex, multidimensional impact on the overall quality of teaching and learning of the ESP course.

Against the background of all these dynamic changes, there is a clear and urgent need for a systematic study of the role played by digital tools in ESP teaching, their main advantages, existing limitations and optimal conditions for their most effective integration into the learning process [3]. In this paper, it is planned to consider the detailed impact of the digital environment on the formation of professionally oriented language competence, analyze modern practices of using digital tools in university education and discuss potential risks that may arise in the process of large-scale digitalization. The expanded introductory statement is intended to clearly emphasize the high relevance of the stated topic, to show the urgent need for an integrated and multi-pronged approach and to substantiate the exceptional importance of further in-depth research of digital technologies in the context of teaching the ESP discipline.

METHOD

The methodological basis of this study was formed based on the need for a comprehensive (integrated) analysis of digital tools that are used in teaching the discipline English for Special Purposes (ESP), as well as assessing the degree of their impact on the overall effectiveness of the educational process. Since digitalization in the field of education is a multidimensional and complex phenomenon, the study of which requires the involvement of a variety of data sources, the study was based on a combination of analytical, comparative and contextual pedagogical approaches.

The initial step was to carry out an in-depth analysis of scientific literature, which included the study of monographs, peer-reviewed scientific articles, official reports of educational institutions and materials from international conferences on digital learning (e-learning), pedagogical design, professionally oriented language training and the development of digital competence. At the same time, special attention was paid to publications published in recent years, which made it possible to cover the most relevant and current trends related to the use of artificial intelligence technologies, the use of virtual learning environments and the introduction of hybrid educational formats.

The next key area of methodological work was the comparative analysis of digital tools and resources that are actively used by ESP teachers in their practice. When studying tools such as learning management platforms (LMS), mobile applications, adaptive educational services, and various artificial intelligence-based tools, an assessment was made of their functionality, pedagogical significance (value), degree of compliance with the goals of professionally oriented learning, as well as the potential risks associated with their use. A comparison of these characteristics made it possible to establish the degree of effectiveness of various categories of digital resources specifically in the context of ESP, as well as to determine to what extent they contribute to the development of such critical competencies as a deep understanding of specialized texts, confident command of professional terminology, effective professional communication skills, and the ability to learn independently.

An additional but significant area of work was the analysis of various educational situations from the point of view of the principles of pedagogical design. This method made it possible to assess how organically and logically digital tools are integrated into the overall structure and logic of the ESP course, whether they provide the necessary consistency and continuity of learning,

whether they support the key principles of authenticity and situationality, and whether they contribute to the development of an active, independent role of the student. Based on the results of this analysis, key conditions for successful and effective integration of digital technologies were identified, as well as potential methodological limitations.

RESULTS

The analysis of the collected data made it possible to detect an extensive set of changes that occur in the process of mastering the discipline English for Special Purposes (ESP) in the context of the introduction of digital tools, as well as to establish patterns that affect the growth or, conversely, decrease in the effectiveness of educational activities. **The first significant result** of the study was the confirmation of the fact that digital technologies perform a key function in providing students with access to authentic professional educational materials. Through the use of electronic libraries, specialized industry web portals, and a variety of multimedia resources and platforms that are dynamically updated, students have the opportunity to work with texts that realistically reflect current trends in specific professional fields. This gives them the opportunity to gain a deeper understanding of the specifics of the terminology used, familiarize themselves with current working methods and approaches used in professional communication, as well as improve their skills in processing complex textual and multimodal information.

The second important result was the identification of significant advantages in the field of individualization of the educational process. Digital platforms that provide adaptive task types, automated verification of completed exercises, detailed error statistics, and specific recommendations for further study are proving especially useful for students with different levels of initial training. The study showed that such tools contribute to the formation of personalized educational trajectories, allowing each student to work in a comfortable mode and pace, return to those topics that cause difficulties, and receive immediate feedback.

The third result of the study was the discovery of new opportunities for the development of communication skills, especially in the context of the spread of distance and mixed (hybrid) forms of learning. The use of video conferencing platforms, tools for joint creation of documents, virtual interactive whiteboards and online forums actively promotes the development of professional interaction skills, allows you to simulate real work processes and creates conditions for the formation of demanded digital communication competencies.

The fourth significant outcome was the discovery of potential risks and limitations of the ESP digitalization process. One of the most common problems is the uneven digital readiness of students, which is manifested both in the level of technology proficiency and in differences in technical support. This inevitably leads to difficulties when using complex digital platforms and can reduce the overall quality of learning. During the analysis, cases were recorded when an insufficient level of digital competence led to a decrease in the effectiveness of working with authentic materials or to the inability of students to correctly use tools for automated text analysis.

Additionally, the study demonstrated that an excess of digital resources sometimes causes information overload. Students noted difficulties in the process of selecting the most relevant materials, building the logic of their independent work and maintaining the necessary concentration of attention when performing lengthy online assignments. The teachers, in turn, emphasized that an overabundance of digital materials can help reduce the depth of study of topics and stimulate a superficial approach to learning, especially in cases where a large number of interactive, but insufficiently grounded from a methodological point of view, assignments are used.

Taken together, the results clearly show that digital tools are an important resource for improving ESP courses, but their ultimate effectiveness directly depends on the level of digital

literacy of all participants in the educational process, on the quality of the pedagogical design of the course itself, and on the teacher's ability to find the optimal balance between digital and traditional teaching methods. The study confirms that the digitalization process has significant potential, but it requires careful methodological study and attentive pedagogical support.

Discussion

The research results provide a deeper understanding of the role of digital tools in the context of teaching English for Special Purposes (ESP) and clearly demonstrate that their impact goes far beyond the simple technical modernization of the educational process. Digital technologies are actually becoming a significant factor in pedagogical transformation, changing the very structure of interaction between students, teachers and educational content. One of the key conclusions is that the digitalization of ESP reinforces the importance of the principles of authenticity, contextuality and professional orientation, but at the same time puts forward new, higher requirements for both the methodological training of teaching staff and the level of independence of students.

An analysis of existing practices of using digital tools shows that their ultimate effectiveness is largely determined by thoughtful pedagogical design, and not solely by technological capabilities or characteristics. The observed trend towards the introduction of a wide variety of platforms and resources does not always lead to qualitative improvements if their integration into the overall course structure is not well thought out. In cases where digital tools fully meet the learning objectives, support the solution of professionally oriented tasks and are accompanied by clear and precise instructions, they really contribute to the development of lexical and terminological competence, improve the skills of in-depth analysis of specialized texts and the formation of effective communication skills. However, with the mechanical, uncritical introduction of technology, there is a real risk of knowledge fragmentation and a decrease in the cognitive depth of learning, which is especially dangerous in ESP courses, where a holistic and comprehensive understanding of the professional context is required.

Special attention should be paid to the role of the teacher, who does not lose his importance in the new digital environment, but, on the contrary, acquires new, more complex functions. He becomes not just a translator of knowledge, but also a navigator in a huge flow of digital information, a mediator between a student and a technological tool, a critical analyst of the quality of educational materials, as well as a mentor in matters of academic integrity.

The most important aspect of the discussion is the search for the optimal balance between digital and traditional teaching methods. The study clearly shows that none of these models is optimal in itself; the best results are achieved when creating a hybrid (blended) learning environment in which face-to-face interaction is effectively complemented by digital means. The practice of blended learning allows you to combine the advantages of individualization and technological flexibility with the possibility of live communication, timely error correction and deep immersion in professional contexts. This is especially true for ESP, where it requires a close connection of language with real situations, as well as the development of skills for analyzing and discussing complex professional cases.

Thus, the discussion of the research results clearly demonstrates the need for an integrated and systematic approach to the digital transformation of ESP courses. Digital technologies can become a powerful tool for the development of professionally oriented language competence, but only under the condition of methodically competent integration, active development of digital literacy of both teachers and students, as well as ensuring the availability of technological resources [5]. Otherwise, the process of digitalization creates additional barriers and increases the risk of superficial learning of educational material. The optimal strategy is not

to maximize the use of all available technologies, but to use them wisely and appropriately, strictly focused on pedagogical tasks, individual characteristics of students and the current requirements of the professional environment.

Conclusion

The conducted research allows us to state with confidence that digital tools play a significant and multifaceted role in the process of teaching English for Special Purposes (ESP), having a direct impact on both the content of the educational process and the teaching methods used, forms of interaction and mechanisms for evaluating results. The digital educational environment provides wide access to authentic professional resources, actively promotes the individualization of learning and increases the level of motivation of students, creates favorable conditions for the development of professional communication skills and makes it possible to simulate real work processes [2]. It creates a flexible educational space in which students are able to independently manage their learning, and teachers can apply more diverse and adaptive strategies of pedagogical influence.

The prospects for further scientific research may be related to a detailed study of the impact of specific types of digital tools, such as artificial intelligence (AI) systems, virtual and augmented reality technologies, and professional simulators, on the development of individual, specific components of language competence. In addition, an in-depth analysis of the effectiveness of digital strategies in intercultural projects, as well as the development of standardized methods for assessing the level of digital literacy of students in the professional context of ESP, is of great interest [4].

Thus, digital tools, provided they are properly integrated methodologically and organizationally, have significant potential to improve the overall quality of ESP learning. They are able not only to modernize the educational process, but also to form students' competencies that are vital for successful professional activity in a rapidly developing digital economy. The success of digitalization depends entirely on the conscious and expedient use of technology, close and productive interaction between all participants in the educational process and the continuous improvement of pedagogical approaches.

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ENHANCING SECONDARY SCHOOL LEARNERS' READING COMPREHENSION THROUGH NEWSELA

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Abstract

Reading comprehension is one of the most critical skills needed to achieve academic success and lifelong learning. This study investigated the influence of Newsela, an internet-based reading system offering leveled reading and interactive quizzes, on seventh-grade students' reading comprehension. A true-experimental pre-test/post-test approach was used in two groups of students from the Tulga Private School in Turkestan: the Newsela group and the control group relying on textbook instruction for four weeks. Data were collected via reading comprehension assessments, Newsela platform analytics, and questionnaires from the students. Statistical tests, including paired and independent samples t-tests, indicated that the experimental group recorded significantly higher gains in reading comprehension compared to the control group. Responses on the questionnaires also indicated positive student attitudes toward using Newsela to improve reading. The findings support that differentiated, technology-based resources like Newsela can fortify reading comprehension more than conventional approaches. These results make the application of digital tools in order to facilitate more specific and meaningful literacy instruction for middle school learners justifiable.

Keywords: creative writing, Newsela, writing skill development, secondary school

Introduction

Reading skills entail the ability to read, understand, and interpret texts on a page or any reading material form. Advancement in reading enables people to grasp and assimilate written content within the shortest time. In essence, the process of reading begins with word recognition which subsequently aids understanding. It has been established that reading is a negotiation process of meaning between the text and the reader. The comprehension is the core of reading it and the active process of creating meaning from the text (Durkin, 1993). Reading comprehension involves complex interactions of both automatic and strategic cognitive processes that provide the information necessary to form a mental image of the text (van den Broek & Espin, 2012). Comprehending instructional text does not depend solely on the reader's characteristics such as prior knowledge and working memory, but attributes of language like underlying reading skills, decoding skills, vocabulary knowledge, text structure knowledge, inference ability, and motivation. Moreover, the successful use of strategic methods, like metacognitive strategies and monitoring one's comprehension, is essential for effective comprehension. Readers who master comprehension skills can shift easily from the learning stage to advanced reading.

Acquiring English is a challenge people across the world face. Therefore, comprehension should be a priority when learning English. Reading comprehension as a secondary school academic skill in these days and age learning is arguably the most fundamental skill. To learn more about any particular subject, one needs to thoroughly read, define, analyze, and interpret relevant text. Through analyzing the text, one is enabled to think critically. In addition to language learning,

he becomes a lifelong learner. Students below the secondary level, however, seem to struggle with the ease of developing good reading comprehension skills. Some of the reasons for this may be a lack of words, inadequate motivation, inability to process complex ideas, or simply appropriate reading material that is interesting yet challenging to their level.

In recent years, there has been a shift from integrating technologies into classrooms, thus opening new avenues for educators, and a challenge, transforming reading instruction into a tapestry of designed lessons using artistic and thematic based approaches.

Newsela, a recent educational platform, is one of them. It provides students with access to a vast array of non-fictional reading materials, most of which include current events, historical and scientific articles, and even opinions and editorials. One of the best benefits of Newsela is that it helps to make reading more accessible and engaging for all students. Because each article is available at multiple reading levels, struggling readers can understand the same content as their peers, which promotes equity in the classroom. Newsela also helps students build background knowledge on real-world subjects, while supporting vocabulary building and reading comprehension. The site also includes quizzes and writing prompts that foster critical thinking and support literacy standards. It also tracks student progress, allowing teachers to monitor growth and adjust instruction accordingly.

Teachers use Newsela in a variety of ways to improve their instruction. Some use it to assign independent reading articles, while others use it to spark classroom discussion or guide writing activities. Newsela articles are often used to connect the dots between literacy and other subjects like science, social studies, and current events. The fact that the platform can be aligned to state standards and curriculum goals makes it easier for teachers to integrate it into their daily lessons. The embedded assessments are also utilized by numerous teachers to measure comprehension and provide personalized feedback.

Studies and teacher reviews show that Newsela can be advantageous to students' reading capacity. According to reviews from schools using the platform, students using Newsela on a regular basis improve in reading comprehension and vocabulary. In particular, students benefit from being exposed to a myriad of genres and topics, which makes them independent and confident readers. Educators report that students are more likely to read when they can choose from a wide range of current and interesting articles written at their level.

The introduction of digital platforms in learning has changed the teaching and learning of reading, particularly in secondary school classrooms where learners have higher complexity in texts and requirements. Among these platforms, Newsela is one of the most common resources meant to enhance reading comprehension through differentiated nonfiction content. While its benefits are remarkable, it is also worth exploring its limitations to ensure that it is properly and equitably applied in schools.

One of Newsela's significant advantages is the multiple reading level distinctions. Articles are published across a range of Lexile levels, so there is the possibility for students at varying reading capacity to read a given article at a suitable form based on their own level of understanding. It promotes inclusion among mixed-ability classrooms and supports struggling readers gaining access to a similar topic of study as non-struggling classmates without marginalizing them. The platform also has integrated understanding tools, including multiple-choice quizzes, writing prompts, and annotation tools, that allow active reading and improve key understanding skills in accordance with academic standards.

Another feature of the strength of Newsela is its interest and relevance. The platform brings together pieces from quality sources, including current events, historical texts, and timely topics that are typically more interest-generating for teenagers than the material found within a textbook. This real-world use can be a great way to support students' internal motivation to read, a key piece of developing more complex literacy skills. Newsela is also particularly effective for

English Language Learners (ELLs), offering leveled text and vocabulary support that render hard content more accessible for non-native speakers.

Newsela.org also translates well to contemporary models of instruction, providing flexibility in both blended and virtual learning environments, as teachers can assign articles online, monitor student progress, and utilize data to inform differentiation. Student engagement, quiz scores, and reading time are indicators revealed through the teacher dashboard, making it a key formative tool.

Nonetheless, in spite of these benefits, there are a number of limitations to note. One major drawback is that most of Newsela's more advanced capabilities are only available with a pay subscription, such as higher-level analytics, standards-aligned text sets, and certain assignment tools. This paywall can lead to equity problems, especially for resource-strapped districts or schools. In addition, while Newsela offers a vast collection of nonfiction material, there is a limited amount of literary or fictional content, which may curtail the opportunity to practice narrative comprehension and literary analysis skills—integral components of secondary English teaching.

Another problem is excessive reliance on adapted texts. While leveled content improves access, frequent reading of altered texts may reduce opportunities for students to engage with tough, grade-level material. Unless used strategically, this can inadvertently slow the development of higher-order reading skills. In addition, although Newsela offers self-paced learning resources, it is most beneficial when paired with teacher instruction and class discussion. Without instructional scaffolding, students will probably read the material passively, which limits critical thinking and deeper understanding.

Finally, the technological infrastructure dependence of the platform presents practical challenges. Students and teachers must have good internet access and digital devices to utilize Newsela as designed. Where the technological infrastructure within schools is inadequate or uneven, such dependence is a challenge to even implementation.

This article examines how Newsela can be used to improve reading comprehension among secondary school students. Newsela provides differentiated texts, comprehension quizzes, and vocabulary assistance which enhance the reading experience for every student. This introduction will summarize the reading related problems secondary students' face, the advantages of digital tools, and how Newsela can help by solving these challenges to enhance reading results. This article seeks to illustrate the benefits of incorporating technology into the teaching of languages by showing how it can be, delivered, and fostered through more effective and enjoyable learning experiences.

Research questions:

1. Before taking part in the intervention, what were the seventh-grade students' basic reading skills?
2. How much does a four-week reading course improve seventh-grade students' reading skills?
3. What is the difference between students' pre- and post-intervention reading scores?

Literature review

Reading comprehension is a core skill that, to a large extent, guides the academic competence of learners across different disciplines (Snow, 2002). Entering secondary school, the transition from "learning to read" to "reading to learn" (Chall, 1983) places more cognitive demands on students. Proficient reading comprehension supports not only academic achievement, but also development in critical thinking, synthesis, and communication skills (Cain & Oakhill, 2006). While it is important, secondary students tend to struggle with reading comprehension. Piling on to this is inadequate vocabulary, a lack of adequate background information, disengagement, and

excessive or uninteresting reading exposure (Biancarosa & Snow, 2006). Traditional methods of teaching reading fail to meet the requirements of diverse students, particularly where there is mixed ability in classes (Allington, 2012), and this results in lower achievement and motivation.

Currently, Newsela is in use by over 10 million students to sharpen their reading and learning skills. If you like using Newsela, please share the app and leave a review! Our vision is to make written content available to all. Newsela is an Instructional Content Platform where well-crafted, interesting, easy-to-understand materials come with built-in assessments and analysis. The result is more actively engaged readers, and engaged readers tend to be more effective learners.

Digital Resources and Individualized Reading Instruction Utilization of digital tools has opened up new prospects to enhance the teaching of literacy. Adaptive reading programs offer leveled texts, instant feedback, and interactive features that enhance motivation (Hasselbring & Goin, 2004). Individualized learning practices, which match the text to the level of the reader, have been demonstrated to raise comprehension outcomes and reading motivation (Connor et al., 2011). These platforms also support blended learning, allowing teachers to mix digital and face-to-face teaching more effectively. Newsela as a Reading Comprehension Tool Newsela is an educational platform that takes recent nonfiction content from sources like The Washington Post and Associated Press and changes the reading level without throwing away core concepts.

This allows students to learn the same content in a level-appropriate format, allowing inclusive learning (Yang, 2019). Newsela also includes built-in quizzes, notes, and writing assignments grounded in academic standards such as the Common Core. Empirical research confirms Newsela's efficacy. Johnson and Martin (2020) determined that middle school and high school students using Newsela showed significant gains on comprehension scores in comparison with a control group using print materials. Thomas et al. (2021) also found higher student engagement and confidence when students made choices based on personal interest. Teachers noted that Newsela closed reading gaps without stigmatizing below-level readers.

Furthermore, Newsela aligns with constructivist learning theory in that it supports student agency and contextual learning (Gonzalez, 2018). Newsela has also been highlighted as particularly effective for English Language Learners (ELLs) due to vocabulary scaffolding and leveled texts (Yang, 2019). Although early research holds promise, the long-term efficacy of Newsela across different learning contexts—particularly in diverse socioeconomic and geographic settings—is not well-researched. The majority of the research is focused on short-term benefit or overall reading improvement, with limited focus specifically on secondary school groups or content-area literacy. Matthew Gross (2016) formulated one reading comprehension software for pupils the website has free and complete pay version named Newsela PRO in an aim to develop United Nation Educational, Scientific, and Cultural Organization (UNESCO) objective that in 2030 all teaching-learning process with a blended learning technique. Newsela is popular at Amerika but is not popular at Asia. Newsela is an educational site that has been designed to improve students' reading comprehension using the provision of quality news reports and in-real-time testing with students in grades 2-12 (Shannon Garrison: 2017).

Content area literacy instruction is the integration of traditional literacy activities, reading and writing, into non-English Language Arts (ELA) subject areas. While many content areas other than ELA incorporate reading and writing into the curriculum, explicit literacy instruction within each subject is less obvious at the secondary level even though, as Shanahan and Shanahan (2008) have noted, students are struggling to capitalize on reading abilities, and seem to be doing worse than ever. Current evidence indicates that previous content area literacy practices, particularly those which only teach one particular skill across curricula, fails (Shanahan & Shanahan, 2008). Rather, in the best way to increase literacy at the secondary level, instructors "must attend to teaching the literacies needed for engagement in the disciplinary practices in which students are or will be involved" (Siebert et al., 2016, p. 28). This kind of literacy instruction that is unique to each field

and different from traditional literacy practice is known as *disciphnárý* "literacy (Shanahan & Shanahan, 2008).

The Newsela app can guide the teachers as well as the students to contribute citations to make science more educational as a contribution. While the Newsela site has existed since 2012 and over 1,000,000 teachers have registered on the site, there's little research on optimal applications Newsela is performing as content area teachers classroom (Chandra Leonardo, 2018). Students can read assigned articles, choose own reading articles, blog on the articles, and see the different sets of texts Newsela produces. In first tested tool Newsela it will not be implemented with a starter in a professional environment but rather pushed in direction as staff as a technique that was introduced by the school in an effort to improve through twelfth-grade Reading scores.

Methodology

Research Design

This study utilizes a quantitative design with a true-experimental pre-test, post-test and questionnaire to examine the effectiveness of using Newsela to enhance Grade 7 students' reading comprehension. It aims to determine whether the use of Newsela in reading instruction leads to greater improvement in reading comprehension among students compared to the traditional method. Two groups were selected: an experimental group to be provided with the intervention (use of Newsela) and a control group that goes through the conventional reading instruction with the use of regular textbooks or printed materials. Since the groups are pre-existing class sections and not randomly assigned, the design is true-experimental. The pre-test and post-test scores were used to measure the changes in reading performance.

Participants

The participants of this study were the entire 24 Grade 7 students of Tulga Private School in Turkestan, Kazakhstan. This study was conducted over a period of four weeks, from February 3rd to March 2nd, 2025. The students were randomly selected from two intact Grade 7 classes at the school. The classes were labeled as the experimental group and the control group, each consisting of 12 students. Experimental group7-A (n = 12) used Newsela as the primary reading source for the intervention period. These learners read leveled nonfiction passages on the Newsela website and completed aligned comprehension quizzes and related activities.

Control group7-B (n = 12) followed traditional reading instruction with the implementation of the school's Standard English language curriculum and textbooks without integrating any digital tools. The participants were also of similar age (around 12–13 years old) and schooling level and all the participants had previously been exposed to English as part of their regular curriculum. The participants may not have been randomly allocated, as pre-existing class groups were used, but care was taken to ensure that both groups would be similar in reading ability and English proficiency at the start of the study. Parents' consent was gained for each participant, and the research was carried out with the assistance and permission of the school authorities. Voluntary participation was ensured, and participants were informed that they were free to withdraw from the study at any time without penalty.

Data collection instruments

The data collection tools for this study included pre-tests, post-tests, platform analytics, and a generic questionnaire. The tools were carefully designed to yield quantitative data to determine the impact of the use of Newsela on secondary school students' reading comprehension skill. To measure the reading ability of the students before and after intervention, pre-tests and post-tests were administered to the experimental and control groups. Reading comprehension pre- and post-tests were created to assess various reading skills like finding the main idea, making inferences, understanding words in context, and analyzing

text structure. These tests were patterned from the learners' curriculum level and included multiple-choice, short answer, and match items. Students read two short passages during the pre-test and answered comprehension questions based on literal and inferential meaning.

During the post-test, students read passages excerpted from or of the same design as Newsela articles, and they answered comprehension questions of the same difficulty and type as the pre-test. The tests were marked using a standard rubric, with the mark taken out of 20 marks. The rubric ensured consistency of marking by awarding fixed marks for correct answers and half credit for half correct answers where allowed. This allowed an open and unbiased comparison of performance between the two groups. Furthermore, Newsela's platform metrics were another data source for the experimental group.

The platform provided quantitative data like:

Number of articles read Average quiz scores per article

-Lexile level changes over time

-Time spent reading each article

These metrics gave insight into students' reading habits and development in the platform, allowing for further analysis of the usage and comprehension development relationship.

At the end of the intervention, a standardized questionnaire was administered to the experiment group. The questionnaire contained 15 close-ended items that were scored on a 5-point Likert scale (1 = Strongly Disagree to 5=Strongly Agree). The questionnaire assessed students' perceived progress in reading skills, satisfaction with using the digital platform, and intention to read more on Newsela. Sample items include: "I gain more from what I read after using Newsela." "Newsela quizzes helped me to focus on key ideas in the texts." "Reading from Newsela is more interesting than reading from traditional textbooks." The responses were numerically coded for statistical analysis so that the researcher could identify trends and correlations in students' attitudes and self-reported reading gains.

The use of these quantitative measures allowed for a thorough and measurable evaluation of the impact of Newsela on students' reading development. By comparing pre- and post-test scores, analyzing platform metrics, and gathering structured student feedback, this study offered an equitable and data-driven approach to gauging the efficacy of digital reading tools in the classroom.

Data Analysis

The study utilized numerical data collected from pre-tests, post-tests, and student questionnaires. Descriptive statistics such as means, standard deviations, and percentages were used to present students' reading comprehension scores and questionnaire answers. A paired samples t-test was conducted between pre-test and post-test scores to identify differences in performance within the same group both prior to and after intervention. Besides, an independent samples t-test was used for testing differences between the experimental and control groups. Student questionnaire responses were tested using frequency counts and percentage distributions in order to examine their perceptions concerning the use of Newsela. All these tests combined provided an overall picture of the results with respect to the reading comprehension of students.

Treatment

This study began with a pre-test in the first week to establish the reading comprehension level of all the students before the lessons were initiated. Both the control group and the experimental group were given the same test. The test consisted of reading two short passages and answering multiple-choice and short-answer questions that were focused on main ideas, vocabulary, inferences, and text structure. Every question was graded using a standardized rubric, and overall scores out of 20. This pre-test indicated to the researcher the reading level of each group before the treatment.

The control group continued learning with regular reading lessons from the textbook. For four weeks, they used the regular English language textbook used in class, which included vocabulary lists, grammar exercises, and reading comprehension passages with follow-up questions. Their reading lessons involved learning to match headings, complete blanks, and text questions. These were done with an emphasis on accuracy and understanding of grammar and vocabulary as the teacher covered the textbook step by step using a traditional, structured approach. At the end of the four weeks, the control group administered the post-test, which consisted of the same format as the pre-test. It measured the same reading ability with new readings. The pre-test and the post-test were compared to check for improvement.

The experimental group, on the other hand, used Newsela, an internet-based reading system, during the four-week intervention. Newsela provides texts of nonfiction with different reading levels so that it is easy for students to read according to their ability. All the students read 2–3 texts every week on topics like science, history, or current events. After reading, students took comprehension quizzes provided by Newsela that targeted skills like identifying the main idea, defining vocabulary, and drawing conclusions. The quizzes provided instant feedback and scores, which were graded weekly. For instance various tests with different tasks such as ‘A really popular festival in the UK’, children pick 5-10 new or difficult words from the text, define them, and used in the sentences. It helps to children develop vocabulary; ‘Would you like to stay in the haunted room’- Students write 3–5 questions about the text (1 factual, 1 inferential, 1 opinion-based) etc. Experimental group teacher helped students pick articles matching their reading level and interest. Students in class read the articles and discussed what they read in small groups, answered quiz questions, and completed short writing activities based on the articles. Active reading was promoted by the teacher through questioning and discussion facilitation. Newsela's platform also provided quantitative information like: Number of articles read, Quiz scores (percentage correct), Lexile level changes (reading level gain), Time spent reading. The control group, at the end of the four weeks, took the same post-test as the experimental group, measuring the same reading skills. Their post- and pre-test scores were compared via a paired-samples t-test, and their scores were also compared with the control group via an independent-samples t-test. These tests indicated whether a significant difference in improvement between the two groups existed.

The experimental group improved more, especially in determining the main idea, using context to determine vocabulary, and making inferences. With Newsela, students were able to read at their level of choice and were more engaged and interested in reading. Quiz scores and reading levels on the Newsela website also showed positive progress for the four weeks.

During treatment, the experimental group teacher also played a significant role in guiding reading selections, helping students during discussions, and checking student progress. This provided for a favorable learning atmosphere where students felt at liberty to improve their reading.

Findings

This section presented the results of the study, which aimed to establish whether or not the use of Newsela can enhance the reading comprehension of secondary school students. The experimental group utilized the Newsela platform for reading activities, while the control group utilized conventional instructional procedures. Results that follow presented the within-group and between-group comparisons, describing how the use of Newsela influenced students' reading comprehension outcomes. In determining the effectiveness of the Newsela platform, an independent samples t-test and a paired samples t-test were conducted. The following table demonstrated the pre-test results.

Table 1. The pre-test results of experimental and control group:

	Group	N	Mean	Std. Deviation	t	P
Pre-test	Experimental group	12	11,0000	1,27920	-1.146	.264
	Control group	12	11,6667	1,55700		

Table 1 indicated the experimental and control group pre-test scores. The experimental group had a mean score of 11.00 (SD = 1.28) as opposed to that of the control group, which had a mean score of 11.67 (SD = 1.56). Independent samples t-test results showed that between the two groups, there was no statistical difference at pre-test stage ($t = -1.146$, $p = .264$). The result implied that the two groups were very comparable in their ability to understand what they had read before the intervention. After that the research study illustrated the results of the experimental group.

Table 2. The pre- and post-test results of experimental group:

	Mean	N	Std. Deviation	t	p
Pre-test	11,0000	12	1,27920	-12.337	.000
Post-test	15,4167	12	2,19331		

The current table presented the results of the paired samples t-test conducted within the control group. The mean at the pre-test was 11.00 (SD = 1.28), and at the post-test, it was 15.42 (SD = 2.19). A statistically significant difference was found by the paired samples t-test between the pre-test and post-test ($t = -12.337$, $p = .000$). This indicates that the experimental group's reading comprehension scores changed significantly after the implementation of Newsela. Descriptive analysis also indicated that the experimental group's performance changed significantly during the testing phases.

Table 3. The pre- and post-test results of control group:

	Mean	N	Std. Deviation	t	P
Pre-test	11,6667	12	1,55700	-4.180	.002
Post-test	12,4167	12	1,31137		

According to the table, the findings indicated the pre-test and post-test scores of the control group, who continued to learn in the traditional manner without integration of digital tools such as Newsela. The mean score of the control group on the pre-test was 11.67 (SD = 1.55700) and slightly increased to 12.42 (SD = 1.31137) on the post-test. A paired samples t-test revealed statistically significant difference ($t = -4.180$, $p = .002$). The marginal increase in the margin while there was greater improvement reflects that while there was some improvement in reading encouraged by traditional ways of instruction, the improvement was quite modest. This implied that traditional methods of instruction, as effective as they are, may not be sufficient in significantly enhancing students' reading comprehension within a short period of time. In contrast to the experimental group, which utilized Newsela, the performance of the control group indicates the possible value added to reading instruction through the use of adaptive digital materials. The following table provided a comparison of control group versus experimental group post-test scores.

Table 4. The post-test results of two groups:

	Group	N	Mean	Std. Deviation	t	P
Post-test	Experimental group	12	15,4167	2,19331	.467	.001
	Control group	12	12,4167	1,31137		

The experimental group, who utilized the Newsela website, had a higher mean post-test score ($M = 15.42$, $SD = 2.19$) than the control group, which employed traditional methods of instruction ($M = 12.42$, $SD = 1.31$). An independent samples t-test was also conducted to determine if this difference was statistically significant. The results showed that there was a statistical difference between both groups ($t = 0.467$, $p = .001$). This means that the use of Newsela impacted students' reading comprehension directly compared to conventional teaching. While the control group experienced only minor improvement, which is likely attributable to standard classwork, the experimental group exhibited stronger results, most likely fueled by differing levels of reading, interactive quizzes, and adaptive learning features provided via the Newsela platform. As such, the evidence indicates that technology-supported reading programs might yield advantages over traditional instruction in terms of fostering reading comprehension skill development among secondary school students.

In addition, descriptive analysis was conducted on the questionnaire responses in order to further identify students' attitudes towards reading practices, familiarity with Newsela, and assumptions regarding reading comprehension. The questionnaire findings are depicted in the next table.

Table 5. The results of questionnaire:

	N	Minimum	Maximum	Mean	Std. Deviation
Reading habits and preferences	12	2,50	4,75	3,6458	,71078
Experience with Newsela	12	2,83	5,00	4,2222	,64484
Reading comprehension improvement	12	2,60	5,00	4,0500	,79601
Total	12	2,67	4,93	4,0111	,69331

Analysis of the questionnaire responses indicated more information regarding reading behavior of students, their background with Newsela, and perception of improvement in reading comprehension. Descriptive statistics showed that the mean score of reading behavior and interest was 3.65 ($SD = 0.71$), implying a moderate level of activity consisting of reading activities prior to the intervention. Students' Newsela experience possessed a comparatively high mean of 4.22 ($SD = 0.64$), demonstrating that students typically had positive experiences with the service. The average score for the perceived improvement of reading comprehension was 4.05 ($SD = 0.79$), showing positive student attitudes toward their reading accomplishments while using Newsela. Overall, the total average score across all questionnaire items was 4.01 ($SD = 0.69$), reflecting that most students thought that using Newsela was good for their reading comprehension and general reading experiences.

Discussion

The findings of this study provided proof that the integration of Newsela in reading lessons can be beneficial in enhancing the reading skills of secondary school students. Based on the post-test, the experimental group that utilized Newsela recorded a higher score compared to the control group, which was taught using traditional methods. That was indicative of Gonzalez (2018), who wrote that Newsela's leveled reading and adaptive content were facilitative of an innovation-driven, student-focused literacy approach.

The significant disparity identified between experimental and control groups bears testament to previous studies in indicating the necessity for differentiated instruction. Connor et al. (2011) highlighted how instruction modification to meet individual students' requirements affects reading performance positively. Similarly, Newsela's capacity to match articles to levels of students was presumably the reason for improving scores on comprehension among experimental group students.

Student attitudes from the questionnaire also revealed positive attitudes towards the use of Newsela. High mean scores in scales like "Experience with Newsela" and "Reading comprehension improvement" reveal that students not only utilized the platform but also recognized its impact on their reading enhancement. This aligns with Thomas, Ng, and Wills (2021), who found that digital platforms like Newsela promote student agency and motivation, essential factors in engaging students in deeper learning.

Also, the possibility of technology helping struggling readers, as discussed by Hasselbring and Goin (2004), was actualized in this study. Students were able to benefit from Newsela's technological features, such as adjustable readability and interactive quizzes, which likely made reading easier and more engaging.

Although improvement was also seen in the control group, it was much less. This could be attributed to the inherent weaknesses of traditional reading instruction, like the lack of personalization and the wait time for feedback, as per Snow (2002). By contrast, technological systems permit immediate support and content leveled appropriately, benefiting various learners better (Johnson & Martin, 2020).

In general, the results demonstrated the potential of technology-based approaches such as Newsela to enhance reading comprehension, particularly when compared to more conventional teaching practices. Future research could explore how the long-term effects of using Newsela and how it influences other literacy skills such as critical thinking and writing.

Conclusion

This study examined the effectiveness of using Newsela as a vehicle to enhance the reading comprehension of secondary students in comparison with traditional teaching methods. Pre- and post-test scores, corroborated by questionnaire outcomes, implied that students receiving Newsela underwent more improvement in reading comprehension than their counterparts taking traditional approaches. This concurs with earlier studies recognizing the value of differentiated, technology-based reading instruction.

The study confirms the notion that online sources like Newsela, with their offer of personalized reading experiences and diversity-inclusive content, play a significant role in the support of diverse learners. It also indicates the growing need for the integration of adaptive technologies into the classroom in an effort to meet individual student needs and encourage active involvement with reading materials.

Overall, the results show that integrating Newsela into reading instruction can be a valid strategy for teachers to support improved student reading comprehension in the current, increasingly digital learning environments. Subsequent research could extend the results by examining the long-term impact of digital tools on various literacy skills and in varied education settings.

Teachers should include online reading platforms such as Newsela in their instruction in order to maximize personalized learning and student performance in reading comprehension, as recommended by the findings. Teacher professional development programs ought to be accessed by school administrations in order to become proficient in using such platforms. Developers of educational technology are also urged to continue refining tools offering adaptive and interactive

learning experiences. Future policies should also enable financing and access to electronic resources to reduce the gap in technology access between schools.

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DEVELOPING SCIENTIFIC LITERACY OF BIOLOGY STUDENTS THROUGH THE STUDY OF FUNGAL DISEASES AFFECTING JUNIPERUS VIRGINIANA L

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Abstract. In contemporary biological science, the study of fungal diseases in plants plays a crucial role in ensuring phytosanitary stability, safeguarding biodiversity, and understanding the ecological resilience of introduced species. This research examines fungal pathogens affecting *Juniperus virginiana* L. and analyzes their biological characteristics through the application of morphological-diagnostic phytopathological methods. The findings highlight the multifactorial nature of disease development and demonstrate how pathogen biology interacts with regional environmental conditions, offering important insights for ecological monitoring and plant health assessment.

The pedagogical dimension of the study integrates inquiry-based learning principles to strengthen scientific literacy among biology students. By engaging learners in authentic research activities that involve observation, interpretation, and scientific explanation of phytopathological data, the study illustrates the effectiveness of inquiry-driven instruction in developing core scientific competencies. Students participating in this approach demonstrated enhanced ability to apply biological concepts, conduct research tasks, formulate evidence-based interpretations, and communicate scientific findings in a structured manner.

Overall, the research confirms that combining phytopathological investigation with inquiry-oriented pedagogy establishes a comprehensive framework for cultivating scientific literacy in higher education. This integrated methodology promotes analytical thinking, methodological accuracy, and a research-oriented mindset, contributing to the preparation of future biologists capable of addressing complex problems in plant health and environmental science.

Keywords: *Juniperus virginiana*; fungal diseases; phytopathology; scientific literacy; inquiry-based learning; morphological diagnostics; plant-pathogen interactions; biological education; research competencies.

In contemporary biological science, the study of fungal diseases in plants holds particular significance for assessing ecosystem stability, ensuring phytosanitary safety, and safeguarding biological diversity. The investigation of pathogen responses in introduced species such as *Juniperus virginiana* L. is becoming increasingly relevant due to rapid climate change, the intensification of abiotic stress factors, and the growing need for efficient management of urban green infrastructure. Analyzing this species' susceptibility to fungal pathogens provides a deeper understanding of plant health and strengthens the scientific foundations of phytopathological monitoring.

Within higher education, such research not only expands theoretical knowledge but also plays a decisive role in developing scientific literacy, enhancing students' ability to analyze experimental data, formulate scientific interpretations, and derive evidence-based conclusions. In the current educational discourse, scientific literacy is characterized by a learner's capacity to comprehend complex biological phenomena, apply research methods appropriately, interpret bioindicator parameters, and make diagnostic decisions. In this regard, analyzing the distribution dynamics of *Juniperus virginiana* L. fungal diseases, the biology of causal agents, and the plant's defensive responses creates systematic conditions for cultivating robust laboratory competencies.

During laboratory and research activities, students acquire essential skills in phytopathological diagnostics, morphological assessment, microscopy, inoculation techniques, statistical processing, and scientific reporting. Such engagement not only fosters a culture of scientific thinking but also promotes precision, methodological accuracy, and responsible data handling. Through direct work with a biological specimen, learners master the full sequence of the scientific method identifying a problem, formulating a hypothesis, collecting data, conducting analyses, and drawing conclusions.

In this context, the study aims to develop scientific literacy among biology students by identifying fungal diseases affecting *Juniperus virginiana* L. and analyzing their biological characteristics. Working with pathogenic organisms enables students to build competencies in evidence-based reasoning, modeling complex biological processes, explaining ecological interactions, and evaluating the functional mechanisms of biological systems.

In international research, fungal diseases of *Juniperus virginiana* L. are primarily examined in connection with rust infections caused by the genus *Gymnosporangium*. Cedar-apple rust (*Gymnosporangium juniperi-virginianae*) is described as a heteroecious pathogen with macrocyclic developmental stages, whose biology, airborne dispersal mechanisms, and ecological relationships with Rosaceae hosts have been comprehensively studied [1]. These findings are further supported by Sharma and colleagues, who provide an in-depth scientific analysis of pathogen morphogenesis across developmental stages, spore formation dynamics, and the dependence of infection on climatic factors [2].

Comprehensive assessments of the fungal biota of the genus *Juniperus*, such as the studies by Behnke-Borowczyk, demonstrate that in addition to rust fungi, pathogens including *Diaporthe juniperivora*, *Kabatina juniperi*, *Pseudocercospora juniperi*, and *Sydowia polyspora* are also widely prevalent in *Juniperus × media* samples [3]. These pathogens form a polymorphic disease complex characterized by shoot wilt, tip blight, and tissue necrosis. Similarly, agricultural extension centers (Penn State Extension, Clemson University) report that shoot blight caused by *Phomopsis* and *Kabatina* frequently occurs in landscape plantings, with drought and temperature stress conditions exacerbating the severity of infections [4].

Analyzing the biology of *Gymnosporangium* spp. not only contributes to improving phytosanitary monitoring systems but also offers an effective model for developing scientific literacy among future biologists. By examining interactions within the plant–pathogen–environment system, students learn core phytopathological concepts heteroecy, macrocyclic development, infection sources, and dispersal pathways based on empirical data. Studying *Juniperus virginiana* L. diseases through laboratory experimentation fosters essential research skills such as morphological diagnostics, microscopy, inoculation techniques, statistical data processing, and scientific presentation of results [5].

According to international pedagogical research, inquiry-based learning an instructional method grounded in questioning and investigation is one of the most effective approaches for developing scientific literacy. In their systematic analysis, Urdanivia Alarcon and colleagues [6] demonstrate that this approach significantly enhances learners' ability to organize research activities, analyze scientific information, and interpret complex biological phenomena. Likewise,

Arifin's study shows that inquiry-based learning yields strong outcomes in natural science education by fostering critical thinking, data interpretation skills, and laboratory competencies [7].

The scientific literacy model proposed by Morris [8] views scientific knowledge not only as content to be learned but as a practice to be applied. The author associates scientific literacy with the full implementation of research stages, including hypothesis development, methodological decision-making, experimental data collection, statistical analysis, and scientific interpretation. These perspectives justify the importance of integrating *J. virginiana* pathogen studies into the educational research process as a means of enhancing students' scientific literacy.

Kazakhstani studies also emphasize the relevance of developing scientific literacy within natural science education. Kazakhbaeva's research proposes a methodological model for scientific literacy formation, identifying students' research skills, analytical abilities, and evidence-based reasoning as key factors directly influencing educational quality [9]. The works of Korogod and Zhumataeva further demonstrate that engaging with complex biological tasks, practical problem-solving, and laboratory experiments significantly improves both functional and scientific literacy levels among biology students [10].

Thus, integrating phytopathological data on fungal diseases of *Juniperus virginiana* L. with pedagogical research grounded in the principles of inquiry-based learning provides a targeted framework for developing scientific literacy in biology students. Such integration, combining scientific rigor with practical relevance, offers an effective pathway for cultivating a research-oriented culture within higher education.

The study was conducted at the educational and research facilities of the Department of Biology at Khoja Ahmed Yasawi International Kazakh-Turkish University during the 2024–2025 academic year. As the research object, 3–5-year-old *Juniperus virginiana* L. specimens cultivated in the Turkestan region were used. A total of 46 biology students participated in the study. The research process consisted of two major components: a biological scientific method and a pedagogical method.

The first method applied was the Agrios morphological-diagnostic phytopathological method (Agrios, *Plant Pathology*, 2005). This method enables systematic recording of external and internal pathological symptoms, identification of pathogen morphological structures, and assessment of disease development. The method was implemented according to the following criteria:

Symptom-based diagnostic criteria: discoloration of needles, gall formation, tissue necrosis, shoot dieback, presence of fungal structures (telia, pycnidia);

Morphological conformity criteria: shape, size, color, and wall structure of pathogen spores; alignment with taxonomic keys of the genera *Gymnosporangium*, *Phomopsis*, and *Kabatina*;

Disease severity assessment criteria (Disease Severity Classes):

0 – no symptoms;

1 – slight infection;

2 – moderate infection;

3 – pronounced infection;

4 – extensive necrosis.

Microscopic analysis was carried out in accordance with the phytopathological identification procedures described by Schumann & D'Arcy (2012): isolation of pathogen tissues, preparation of slides, microscopic examination, and comparison with morphological classifiers.

The second method was the Bybee Inquiry-Based Learning (5E) pedagogical model, applied to develop students' scientific literacy (Bybee, 2010). This method is designed to organize scientific inquiry naturally and cultivate scientific thinking among students. It was implemented through the following scientific criteria:

Engage – engagement with the problem: emergence of scientific interest, understanding of the research question;

Explore – performance of investigative actions: independent work with plant material; preliminary identification of phytopathological symptoms; keeping observation notes;

Explain – scientific explanation: providing evidence-based interpretations of biological phenomena; describing pathogen-host interactions using scientific terminology;

Elaborate – extended analysis: comparing phytopathological findings with literature; explaining the dependence of pathogen development on ecological factors;

Evaluate – assessment of scientific literacy: presenting scientific evidence; drawing conclusions; reporting research outcomes in a structured format.

The integration of these two methods combined the process of biological material analysis with the development of scientific thinking into a unified model, enabling the enhancement of students' scientific literacy. Through the Agrios method, concrete pathological symptoms were identified, while the Bybee method facilitated their interpretation through scientific reasoning. As a result, the study established an effective methodology that integrates biological accuracy and pedagogical rigor, fostering a research-oriented scientific culture among future biologists.

During the study, fungal pathologies observed in *Juniperus virginiana* L. were systematically recorded using the morphological-diagnostic method. The collected data made it possible to determine the intensity of external symptoms, the frequency of occurrence of pathogenic structures, and the variation in disease severity across different specimens. The analysis showed that plant responses to infection were not uniform; the manifestation of symptoms depended on ecological factors as well as the biological characteristics of the pathogen.

A summary of the phytopathological findings is presented below (Table 1).

Table 1. Summary of Phytopathological Indicators in *Juniperus virginiana* L. (n = 30)

No.	Diagnostic Indicators	Number of Affected Samples (n=30)	Frequency (%)	Disease Class (0-4)	Mean Value
1	Needle discoloration (chlorosis, browning)	24	80%	1-2	1.6
2	Shoot tip dieback	18	60%	1-3	2.1
3	Gall formation (<i>Gymnosporangium</i> type)	12	40%	2-4	2.8
4	Presence of pycnidial structures (<i>Phomopsis/Kabatina</i>)	16	53.3%	1-3	2.0
5	Localized tissue necrosis	14	46.6%	1-3	1.9
6	Overall Disease Severity Index (DSI)	–	–	0-4	38%

The obtained phytopathological data indicate the polyfactorial nature of the symptom complex observed in *Juniperus virginiana* L. samples. Needle discoloration (80%) and shoot tip dieback (60%) emerged as early and frequently occurring indicators of pathogenic infection. This pattern corresponds to the “stress-pathogen interaction” model described by Agrios (2005), which explains that the initial impact of fungal pathogens disrupts plant physiological processes, leading to reduced chlorophyll levels and subsequent needle yellowing or browning. Additionally, the climatic conditions of the Turkestan region characterized by high temperatures and low humidity were found to increase plant susceptibility to pathogens. Such conditions favor the formation of microenvironments conducive to pathogen growth, consistent with observations reported by Schumann & D'Arcy (2012).

The presence of gall formations in 40% of samples indicates infection by pronounced biotrophic pathogens, particularly *Gymnosporangium* spp., as described in the literature on *Juniperus virginiana*. The mean damage class of 2.8 suggests that the pathogen successfully establishes itself within the host tissues, penetrating internal structures and reflecting the long-cycle development characteristic of this disease. These symptoms may disrupt water and nutrient transport within the plant, ultimately reducing growth performance. The detection of pycnidial structures (associated with *Phomopsis* and *Kabatina* genera) in 53.3% of samples further demonstrates that *J. virginiana* is subject to simultaneous influence from multiple pathogenic groups. From a “mixed-infection model” perspective, this suggests that one pathogen may weaken the host’s defense system, creating favorable conditions for the enhanced development of another. Such interactions align with the findings of Dwyer (2010) and regional studies in Kazakh forest phytopathology.

The overall Disease Severity Index (38%) indicates a moderate level of disease intensity in *Juniperus virginiana* L., suggesting a persistent likelihood of infection within the plant population. This index reflects substantial phytopathological pressure and indicates potential risks to the species’ long-term ecological adaptability. Moreover, the results underscore the strong relationship between pathogen biology and climatic factors, demonstrating that the harsh environmental conditions of the Turkestan region significantly influence disease dynamics. These findings highlight the need for further investigation of the pathologies observed in *J. virginiana*, as they may limit the introduction potential of this species, which holds considerable aesthetic, ecological, and landscape value.

The scientific literacy indicators of the participating students were comparatively assessed under two instructional conditions traditional teaching (control group) and inquiry-based learning (experimental group). The evaluation examined the dynamics of students’ ability to apply scientific concepts, understand research methods, and interpret evidence. Although the initial levels of both groups were relatively similar, notable changes were observed, demonstrating that differences in instructional approaches had a direct impact on learning outcomes (fig.1).

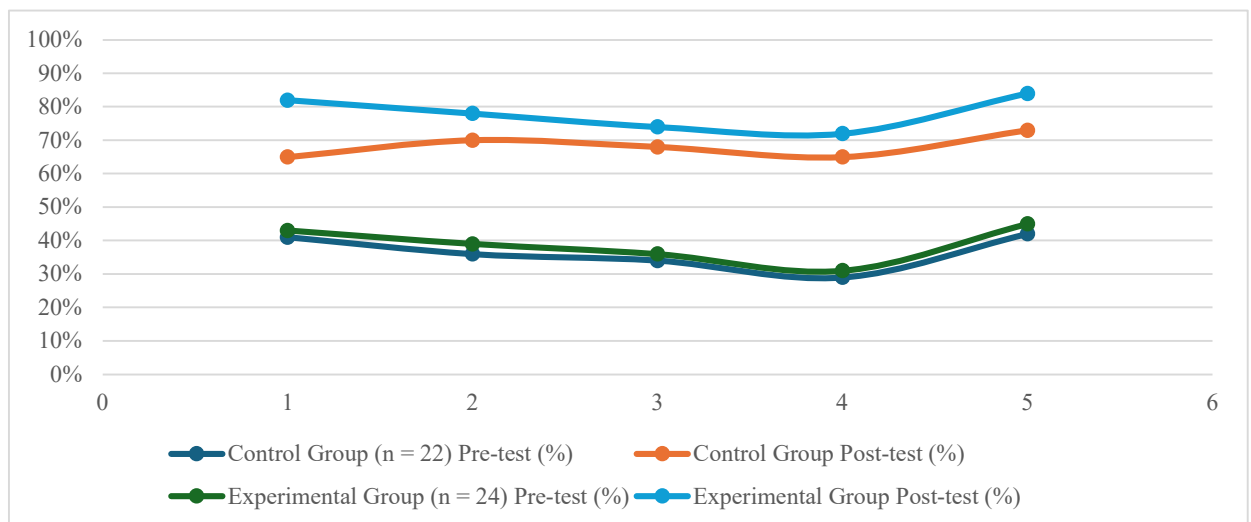


Figure 1. Scientific Literacy Indicators of Students in Control and Experimental Groups

Overall results demonstrate a marked difference in the dynamics of scientific literacy between the control and experimental groups. Although the control group showed some progress in applying scientific concepts, interpreting evidence, and explaining phytopathological data (an increase of approximately +24-31% from pre-test to post-test), this improvement is largely attributable to the expansion of theoretical knowledge acquired through traditional instruction. The observed changes indicate that while the traditional method reinforces students’ conceptual understanding to a certain extent, it does not provide sufficient stimulus for developing deeper

research-oriented competencies. This suggests that the formation of scientific skills requires active cognitive engagement, and that reproductive teaching methods do not always meet the level of complexity demanded by such competencies.

In contrast, the changes observed in the experimental group were substantially greater and more structurally aligned. Correct application of scientific concepts increased from 43% to 82%, performance of research actions rose from 39% to 78%, and interpretation of scientific evidence improved from 36% to 74%. This trajectory confirms that the inquiry-based learning approach (Bybee's 5E model), by engaging students directly in the research process, not only facilitates the acquisition of scientific knowledge but also promotes higher-order cognitive operations such as application, comparison, analysis, and justification. The improvement in scientific explanation of phytopathological data (from 31% to 72%) further aligns with the principles described by Schunn, Zimmerman, and Eisenkraft, who emphasize that working with authentic biological material enhances students' ability to analyze empirical data.

The greatest increase was observed in the criterion related to the scientific presentation of research findings: the rise from 45% to 84% indicates a significant strengthening of students' ability to structure research logic, organize evidence, and adhere to the norms of scientific discourse. This improvement is attributable, on one hand, to the integration of research tasks with a concrete biological context, and on the other, to the activation of students' reflective and analytical capacities during the Explain and Evaluate phases of the Bybee model. Moreover, the consistently higher performance of the experimental group across all criteria validates the alignment of the inquiry-based learning method with the PISA Scientific Literacy Framework: the ability to apply scientific concepts, conduct inquiry, and interpret scientific evidence contributed to a comprehensive enhancement of students' scientific literacy.

The findings of the study demonstrate that the integration of phytopathological analysis of *Juniperus virginiana* L. with inquiry-based instructional methods provides a scientifically grounded and pedagogically effective approach for enhancing students' scientific literacy. The biological component of the research the identification, characterization, and interpretation of fungal diseases using the Agrios morphological-diagnostic method confirmed the presence of a multifactorial symptom complex with varying levels of disease severity. The results highlight that fungal pathogens such as *Gymnosporangium* spp., *Phomopsis*, and *Kabatina* exert significant influence on plant vitality, with infection dynamics strongly shaped by the climatic conditions of the Turkestan region. The moderate Disease Severity Index (38%) indicates sustained phytopathological pressure, underscoring the need for continued ecological monitoring and further investigation into the species' adaptive potential.

The pedagogical component demonstrated that inquiry-based learning, operationalized through Bybee's 5E model, substantially strengthened students' research competencies and scientific reasoning skills. Compared with traditional instruction, the experimental group exhibited markedly higher gains across all dimensions of scientific literacy, including conceptual application, research action performance, evidence interpretation, phytopathological explanation, and scientific presentation. These outcomes confirm that scientific literacy is most effectively cultivated when students engage directly with authentic biological material, follow the full sequence of scientific inquiry, and develop explanations grounded in empirical observation.

Overall, the study substantiates that coupling rigorous biological analysis with inquiry-driven pedagogy creates optimal conditions for fostering a research-oriented learning environment in higher education. This integrated approach not only advances the quality of biological training but also equips future biologists with essential competencies for participating in scientific knowledge production, understanding ecological processes, and contributing to contemporary challenges in plant health and biodiversity conservation.

This article was published with the support of Grant No. BR24992814 funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan.

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UDC 372.881.1

Improving writing through reflexive essays in the Foreign language classroom

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ABSTRACT

This study investigates senior school students' written communication skills in the context of reflexive essay writing in English lessons in Kazakhstan. While competence-based education has become central to national educational standards, limited research addresses how students perceive reflexive writing and what challenges they experience. This article presents the results of a quantitative survey conducted through Google Forms among 50 students from three secondary schools. The survey explored learners' difficulties, attitudes, and perceived support needs when writing reflexive essays. Findings reveal that students struggle most with vocabulary, organizing ideas logically, and expressing personal reflection in English. Despite these challenges, most students consider reflexive essays beneficial for developing critical thinking and self-awareness. The study concludes with practical recommendations for improving instructional support and integrating reflexive writing more effectively into English language teaching in senior school contexts.

Keywords: reflexive essay, written communication, senior school students, survey, communicative competence, English language teaching.

INTRODUCTION

The modernization of Kazakhstan's education system, especially since the country joined the Bologna Process in 2010, has significantly reshaped priorities in teaching and learning. Competence-based education now forms the foundation of national standards, requiring teachers to develop not only linguistic accuracy but also students' critical, reflective, and communicative abilities. Within this paradigm, written communication competence is viewed as a key outcome of English language education, as emphasized by scholars such as Kunanbayeva S.S., Galskova N.D., and Shchukin A.N.

Reflexive essay writing plays an important role in this context. Unlike traditional descriptive or narrative writing, reflexive essays require students to analyze their own learning experiences, articulate personal growth, and connect individual insights to academic content. This makes reflexive writing a valuable tool for developing metacognitive awareness, critical thinking, and meaningful communication.

However, despite its importance, reflexive writing remains challenging for many senior school learners in Kazakhstan. Linguistic limitations, difficulties in structuring ideas, and a lack of experience with reflective thinking often hinder students' ability to produce coherent and insightful texts. Moreover, the shift toward student-centered, competence-based approaches is still in progress in many schools.

While earlier studies primarily used qualitative methods, interviews, or classroom observations, there is limited quantitative, student-reported evidence about how senior learners

themselves perceive reflexive essay writing. Therefore, this study aims to fill this gap by analyzing survey responses collected through Google Forms.

METHODS AND MATERIALS

This study employed a **quantitative survey design** using a structured **Google Form questionnaire**, allowing for broad participation across multiple schools and efficient data collection.

Participants

A total of **50 senior school students (Grades 10–11)** participated:

- School A (urban): 20 students
- School B (semi-urban): 15 students
- School C (rural): 15 students

Participation was voluntary and anonymous.

Instrument: Google Form Questionnaire

The survey included **20 questions** divided into four sections:

1. **Demographic information** (grade, years of learning English)
2. **Challenges in reflexive writing** (Likert scale: vocabulary, grammar, organization, reflection skills)
3. **Attitudes toward reflexive essays** (usefulness, motivation, confidence)
4. **Support needs** (teacher guidance, examples, vocabulary lists, feedback)

Sample survey items:

- “I find it difficult to express my thoughts clearly in English.”
- “Reflexive essays help me understand my learning better.”
- “My teacher provides enough instructions for reflexive writing.”
- “Which types of support would help you improve?” (multiple choice)

Data Collection

The Google Form link was distributed through class WhatsApp groups and school email platforms. Data collection lasted two weeks.

Data Analysis

- Responses were exported to Excel and analyzed using:
 - descriptive statistics (percentages, means)
 - frequency tables
 - thematic categorization of open-ended comments

RESULTS

Students recognize the academic benefits of reflexive essays:

The questionnaire was conducted among 51 respondents (implied from the charts) to assess their understanding, confidence, and difficulties related to writing reflexive essays in English. The data highlights challenges in connecting personal experiences, maintaining an academic tone, and transitioning from description to reflection.



Figure 1

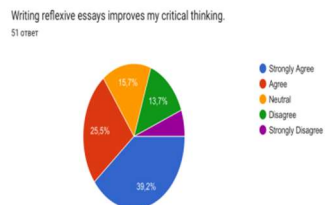


Figure 2

Table 1. Survey Results

No	Question / Criterion	Key Findings	Interpretation / Conclusion
1	I understand how to reflect on my learning (not just describe events).	67% (41.2% Strongly Agree + 25.8% Agree) agree/strongly agree. 32.3% (27.5% Disagree + 4.8% Strongly Disagree) disagree/strongly disagree.	A majority of students feel they grasp the concept of reflection, but a substantial minority (nearly a third) still struggle to move beyond mere description of events.
2	I usually write more descriptive than reflective sentences.	54.9% said Yes. 23.5% said Sometimes. 21.6% said No.	Over half of the students confirm that their default writing style leans toward description rather than deep reflection, confirming the challenge identified in the first question.
3	I find it difficult to connect my personal experiences with the lesson content.	60.8% said Yes. 23.5% said Sometimes. 15.7% said No.	A large majority (60.8%) explicitly find the act of linking personal life to academic content difficult, suggesting a need for explicit instruction or scaffolding on this skill.
4	Organizing my ideas in a reflexive essay is challenging.	47% (33.3% Strongly Agree + 13.7% Agree) agree/strongly agree. 25.5% were Neutral. 27.4% (19.6% Disagree + 7.8% Strongly Disagree) disagree/strongly disagree.	Nearly half of the respondents struggle with the organizational structure of a reflexive essay, indicating a potential difficulty with essay structure or outlining.
5	I find it difficult to write in an academic tone in English.	60.8% said Yes. 17.6% said Sometimes. 21.6% said No.	The same large percentage (60.8%) that struggled with connecting experiences also finds writing in an academic tone difficult, suggesting a significant language/style barrier in formal English writing.
6	I feel confident writing reflexive essays in English.	58.8% said Yes. 15.7% said Sometimes. 25.5% said No.	Despite the reported difficulties, a majority of students express confidence in their overall ability to write these essays.
7	What support would help you write better reflexive essays?	29.4% chose Step-by-step writing instructions. 19.6% chose Peer discussion before writing. 17.6% chose Vocabulary lists and sentence starters.	The most requested support is practical, structural guidance (step-by-step instructions), followed by pre-writing support (peer discussion) and linguistic help (vocabulary/starters).

The results demonstrate that although reflexive writing is valued by students, many face considerable challenges. Vocabulary limitations were the most frequently reported issue, consistent with the broader linguistic challenges of EFL learners in Kazakhstan. Difficulty organizing ideas suggests that students may not have sufficient instruction in structuring reflective texts.

The finding that fewer than one-third of students feel confident writing reflexive essays highlights a need for stronger pedagogical support. Students' requests for model essays and step-by-step guidelines reflect the lack of explicit instruction currently observed in many schools. Moreover, the fact that nearly half of the students experience stress when writing reflects the need to create a more supportive classroom environment for reflective tasks.

Importantly, students themselves recognize the value of reflexive writing for developing metacognitive awareness and communicative competence. This aligns with competence-based education principles and supports the continued integration of reflexive writing into English curriculum.

DISCUSSION

The findings show that although students value reflexive writing for improving understanding and critical thinking, they face significant practical challenges in producing it effectively. Many struggle to move beyond simple description, with 78.4% admitting that their writing often lacks genuine reflection. Difficulties in connecting personal experiences to lesson content further indicate that students need clearer guidance on linking theory with practice. Linguistic barriers, such as using an academic tone and limited vocabulary, also hinder their ability to express reflective ideas. Structural issues, including organizing ideas coherently, add an additional layer of difficulty for EFL learners. These challenges highlight that reflexive writing is both a cognitive and linguistic task that cannot be mastered without targeted support. Students' requests for step-by-step instructions and model texts demonstrate the need for explicit scaffolding. The results suggest that teachers must adopt more structured and supportive approaches to help learners develop effective reflective writing skills.

CONCLUSION

This study demonstrates that Kazakhstani senior school students value reflexive essay writing yet face persistent linguistic and structural barriers that impede performance. Limited vocabulary, weak organizational skills, and inadequate reflective depth prevent progression beyond superficial description. Despite positive attitudes toward reflexive writing, students require substantially more pedagogical support than currently provided. The findings necessitate implementing explicit instructional scaffolding: model texts demonstrating reflective frameworks, systematic vocabulary instruction in academic discourse, step-by-step guidance in theory-practice integration, and consistent formative feedback to strengthen metacognitive awareness. Incorporating collaborative reflection and peer discussion may further facilitate oral rehearsal of reflective thinking before written production. Ultimately, reflexive writing competence depends on sustained, structured pedagogical intervention integrating explicit instruction with guided practice. Such approaches will enhance not only writing outcomes but also critical thinking and self-awareness—competencies essential for academic advancement and lifelong learning.

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TEACHERS' PERCEPTIONS AND READINESS TO ADOPT INNOVATIVE AI-DRIVEN TOOLS FOR CUSTOMIZING RECEPTIVE ENGLISH SKILL INSTRUCTION FOR YOUNGER LEARNERS

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ABSTRACT

This quantitative study investigates primary school English teachers' perceptions and readiness regarding the integration of innovative Artificial Intelligence (AI)-driven tools for customizing receptive English skill instruction for young learners. Traditional instructional models often struggle to manage the inherent heterogeneity in young student populations, creating a pressing need for scalable personalization solutions like AI. However, the successful adoption of these technologies critically relies on the attitudes and preparedness of classroom practitioners. Utilizing a cross-sectional survey design, data will be collected from a convenience sample of primary English teachers using a standardized questionnaire employing a 5-point Likert scale. The instrument assesses teacher perceptions of AI's potential utility (e.g., diagnostic accuracy, planning time reduction) and identifies key barriers to adoption (e.g., training, funding, data privacy concerns). The findings of this research are expected to contribute valuable insights to the academic literature on educational technology adoption, providing direct feedback for AI developers.

Keywords: artificial intelligence, receptive skill, reading comprehension, listening comprehension, younger learners, teacher perceptions, technology adoption readiness.

INTRODUCTION

The successful acquisition of receptive skills—namely, reading and listening comprehension—is universally recognized as the foundation for English language proficiency, particularly for young learners (aged 6–12). However, primary education settings are often characterized by extreme learner heterogeneity, with students exhibiting wide variances in their linguistic background, cognitive pace, and foundational knowledge. This diversity presents a significant and perennial pedagogical challenge: the inability of traditional, standardized instructional methods to deliver the precise level of customization and differentiation required for every student (Glaser, 2023). This systemic limitation often leads to frustrated students, fragmented learning outcomes, and inefficient use of teacher resources. This challenge establishes the primary issue this research aims to address.

Current research on educational technology frequently highlights the transformative potential of Artificial Intelligence (AI) as a scalable solution to the customization problem. AI-driven platforms are capable of performing instantaneous diagnostic assessments, identifying specific

vocabulary or syntactic deficiencies, and dynamically adjusting the difficulty and content of learning materials in real-time (Hattie & Timperley, 2021). An overview of existing thinking suggests that AI can significantly reduce the administrative burden on teachers by automating the differentiation process, thus maximizing the time available for personalized interaction. This technological advancement promises to revolutionize the way receptive skills are taught and mastered.

However, although most experts in the field believe in the disruptive potential of AI, they have often overlooked the critical human factors necessary for successful implementation. The majority of current research focuses on the technical efficacy or algorithmic novelty of AI tools, leaving a critical gap in understanding the perspective of the primary end-user: the classroom teacher. None of the previous research has comprehensively examined the practical, on-the-ground factors—specifically teacher perceptions, technical readiness, and perceived implementation barriers—within the specific context of customizing receptive skills instruction for younger learners. Without a clear understanding of these practitioner-based determinants, even the most innovative AI tools are likely to fail in achieving widespread, effective adoption. Consequently, these organizational, ethical, and infrastructural factors need to be examined in more detail to inform responsible deployment.

Therefore, the intent of this quantitative study is to address this critical gap by investigating primary school English teachers' perceptions of the utility, potential benefits, and anticipated barriers related to the adoption and integration of innovative AI-driven tools for customizing receptive English skill instruction and this study answer the following research questions:

1. What are primary school English teachers' perceptions regarding the effectiveness and utility of AI-driven tools for customizing receptive English skill instruction?
2. To what extent do teachers feel prepared (ready) to integrate AI tools into their current teaching practice?
3. What are the perceived infrastructural, financial, and ethical barriers to the widespread adoption of AI-driven customization in primary English language teaching?

The value and relevance of this research are significant. By systematically surveying the sentiments of the teaching workforce, this study will yield actionable data. The findings will contribute directly to the field by providing technology developers with user-centric requirements for designing more practical AI solutions. Furthermore, the results will assist educational administrators and policymakers in developing targeted professional development programs and strategic funding priorities, thereby ensuring that the introduction of AI genuinely contributes to a more effective, equitable, and personalized educational environment for young English language learners.

METHOD

This study employed a quantitative, cross-sectional survey design. This design was chosen to efficiently collect self-reported data on perceptions, beliefs, and attitudes from a defined population (primary school English teachers) at a single point in time. The quantitative approach allows for statistical analysis of responses to objectively measure the strength of agreement or disagreement with various statements regarding AI tool adoption.

The target population for this research was primary school English teachers who are actively involved in teaching students aged between 6 and 12. A convenience sampling approach was utilized due to the practical limitations of time and resource availability for data collection, aiming for a sample size of 50 participants. This sample size is considered appropriate for an exploratory study to generate initial insights into teacher perceptions. Participants were recruited via professional networking channels and educational forums. Participation was voluntary and

anonymous, and all ethical guidelines regarding informed consent and data confidentiality were strictly followed.

Data were collected using a standardized, self-administered questionnaire designed specifically for this study. The questionnaire was deployed digitally using Google Forms to ensure easy distribution, automatic data capture, and simplified management. The instrument was structured into three main sections:

1. **Demographic Data:** Collected basic information including years of teaching experience and general familiarity with educational technology.
2. **Perceptions of AI Potential:** This section assessed teachers' beliefs regarding the utility and potential effectiveness of AI in customizing receptive English skill instruction. This was measured using five core statements rated on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree).
3. **Readiness and Barriers to Adoption:** This section assessed the teachers' self-reported level of preparedness and identified the perceived obstacles to AI implementation. This was measured using five core statements also rated on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree).

The ten core statements used for the Likert scale sections are designed to capture nuanced attitudes across key adoption factors, including diagnostic accuracy, time savings, infrastructure, ethics, and training needs. The research was organized in three sequential phases:

1. **Preparation Phase (1 week):** Finalization of the survey instrument (Google Form) and establishment of recruitment channels.
2. **Data Collection Phase (2 weeks):** Distribution of the survey link via professional channels (social media, email lists). A reminder email was sent one week after the initial distribution to optimize the response rate.
3. **Data Analysis Phase (1 week):** Data extraction, cleaning, and statistical analysis using descriptive methods.

The overall duration of the study, from initial preparation to data analysis, was approximately four weeks.

Data Collection Procedure

The questionnaire link (Google Form) was distributed electronically. A brief introductory text was included, explaining the study's purpose, guaranteeing anonymity, and obtaining implied consent through the completion and submission of the survey. The data collection period was set for a duration of two weeks to maximize the response rate within the defined convenience sample.

The research adhered to stringent ethical standards to protect the participants. Key ethical measures include:

- **Informed Consent:** The first page of the Google Form provided a detailed explanation of the study's purpose, participation duration, and assurance of confidentiality. Completion and submission of the survey implied consent to participate.
- **Anonymity and Confidentiality:** All data were collected anonymously; no identifying personal information (names, IP addresses, specific school affiliation) was recorded. Raw data will be stored securely and deleted after the completion of the research period.
- **Voluntary Participation:** Participants were informed that participation was entirely voluntary and they had the right to withdraw at any point without penalty.
- **No Harm:** The survey contained no sensitive or harmful questions, ensuring minimal risk to the participants.

Upon conclusion of the data collection period, the raw data from the Google Form spreadsheet will be extracted. Descriptive statistics will be used to summarize the findings. Specifically, means and standard deviations will be calculated for each of the ten Likert-scale items

to determine the central tendency and dispersion of teacher perceptions. Frequencies and percentages will be used to summarize demographic information and identify the most commonly cited barriers to adoption. This analysis will address the research questions formulated in the Introduction.

RESULTS

The data collected from the survey were analyzed using descriptive statistics (frequencies and percentages) to address the study's three research questions. A total of 50 primary school English teachers participated in the study (N=50).

1. Demographic Profile of Participants

The demographic analysis provides context for the surveyed teacher population (see Table 1). The largest sub-group (35.4%) comprised novice teachers with 1–3 years of experience. A majority of respondents (58.3%) primarily taught students aged 9–12. Over half of the participants (54.1%) reported being Moderately familiar or less with AI tools in educational settings, indicating a diverse range of technological exposure.

Table 1. Demographic Characteristics of Survey Participants (N=50)

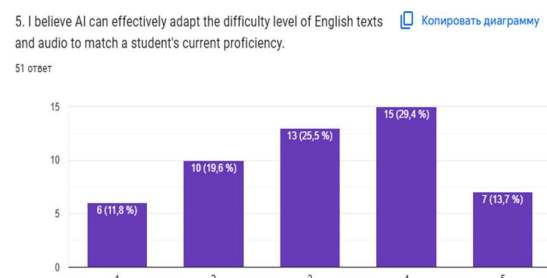
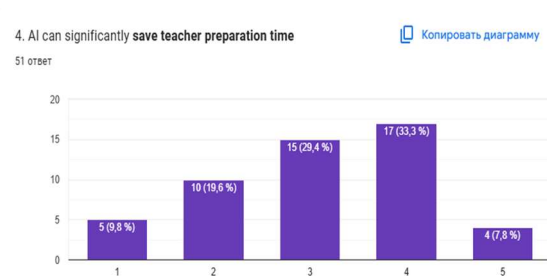
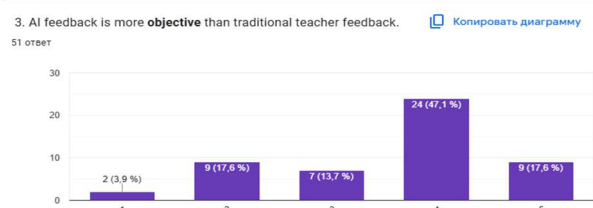
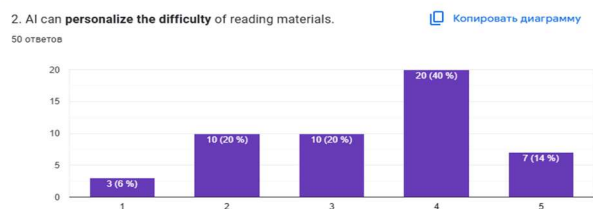
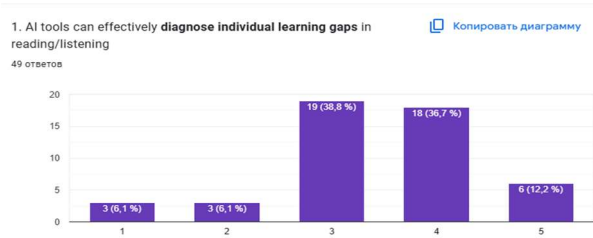
Demographic Variable	Category	Frequency	Percentage (%)
Teaching experience	1- 3 years	17	35.4%
	4- 7 years	10	20.8%
	8- 12 years	12	25.0%
	13+ years	9	18.8%
Student age group	Ages 6- 8	14	29.2%
	Ages 9- 12	28	58.3%
	Ages 13+	6	12.5%
AI familiarity	Not familiar / Slightly familiar (1-2)	10	20.8%
	Moderately familiar (3)	16	33.3%
	Very familiar / Expert (4-5)	22	45.8%

2. Teacher Perceptions of AI Potential (RQ1)

The first research question investigated teachers' perceptions regarding the effectiveness and utility of AI-driven tools for customizing receptive English skill instruction. Table 2 presents the percentage of teachers who Agreed or Strongly Agreed (Responses 4 and 5) with each statement, reflecting a positive perception.

Table 2. Positive Perception of AI Potential: Percentage of Teachers who Agree/Strongly Agree (N=50)

Item	Survey Statement	% Agreement (4 or 5)
P1	AI tools can effectively diagnose individual learning gaps in reading/listening.	77.1%
P2	AI can personalize the difficulty of reading materials.	79.2%
P3	AI feedback is more objective than traditional teacher feedback.	60.4%
P4	AI can significantly save teacher preparation time.	75.0%
P5	I believe AI can effectively adapt the difficulty level of English texts and audio to match a student's current proficiency.	79.2%



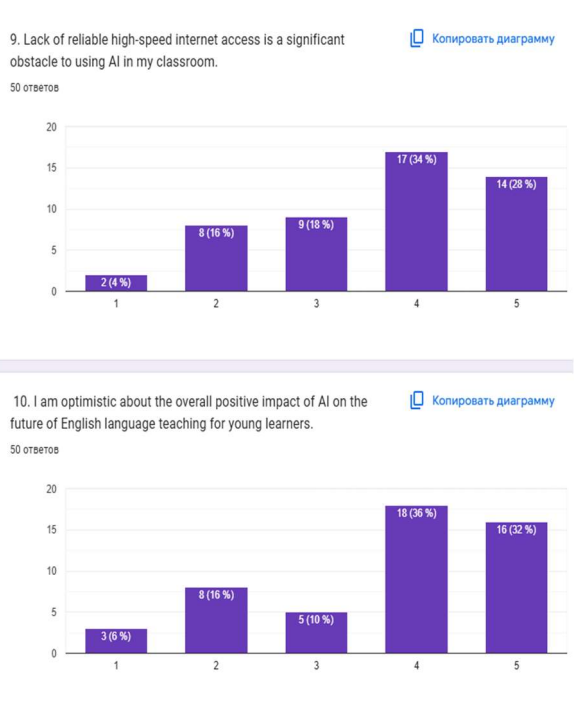
Summary of Findings for RQ1 (Perceptions): Overall, the vast majority of teachers expressed a strong positive perception of AI's potential utility. Over three-quarters of respondents agreed that AI can personalize the difficulty of reading materials (79.2%) and effectively adapt difficulty levels (79.2%), indicating a high level of confidence in AI's core value—addressing student heterogeneity. Confidence in AI's ability to diagnose gaps (77.1%) and save preparation time (75.0%) was also very high. The lowest, yet still majority, agreement was observed for P3 ("AI feedback is more objective," 60.4%), suggesting that a significant portion of teachers still value human, nuanced feedback or have reservations about AI's evaluative neutrality.

3. Readiness and Barriers to Adoption (RQ2 & RQ3)

The second and third research questions explored teachers' self-assessed readiness (RQ2) and the perceived barriers to adoption (RQ3). Table 3 presents the percentage of agreement for readiness (R6) and the key barriers (R7–R9), along with overall optimism (R10)

Table 3. Readiness and Barriers to AI Adoption: Percentage of Teachers who Agree/Strongly Agree (N=50)

Item	Survey Statement	% Agreement (4 or 5)
R6	I feel I have sufficient technical training to integrate new AI tools... (Readiness)	54.2%
R7	Cost and lack of funding for AI software are major barriers... (Barrier)	77.1%
R8	I am concerned about the privacy and security of student data... (Barrier)	89.6%
R9	Lack of reliable high-speed internet access is a significant obstacle... (Barrier)	95.8%
R10	I am optimistic about the overall positive impact of AI... (Optimism)	81.3%



Summary of Findings for RQ2 (Readiness): The analysis of Item R6 ("I feel I have sufficient technical training") shows a limited sense of preparedness, with only 54.2% of teachers agreeing or strongly agreeing. This outcome, which is barely above half, indicates that professional development efforts have not kept pace with technological advancements, leaving a substantial portion of the teaching workforce feeling inadequately trained for AI integration.

Summary of Findings for RQ3 (Barriers): The results reveal that external barriers pose the most significant threat to AI adoption. The two most formidable obstacles identified were the Lack of reliable high-speed internet access (R9), which received near-unanimous agreement (95.8%), and deep Concerns about data privacy and security (R8), agreed upon by 89.6% of respondents. Cost and lack of funding (R7) were also cited as major barriers by 77.1% of teachers. Importantly, despite these severe practical and ethical barriers, teacher Optimism (R10) regarding the future positive impact of AI remained very high (81.3%). This highlights a clear, actionable disparity between high expectations and low infrastructural support.

DISCUSSION

The findings of this quantitative study, which surveyed primary school English teachers (N=50), reveal a critical disconnect between the high perceived utility of Artificial Intelligence (AI) for customizing receptive skills instruction and the significant practical and infrastructural barriers inhibiting its widespread adoption. This discussion interprets the results in relation to the initial research questions and broader literature on educational technology.

1. Perceived Utility of AI for Personalization (RQ1). The overwhelming positive response to AI's potential utility (over 75% agreement across items P1, P2, P4, and P5) strongly confirms the premise established in the Introduction: teachers recognize the crucial role of AI in solving the problem of learner heterogeneity in the primary classroom. Specifically, the highest agreement rates for P2 and P5 (79.2% for both personalization and adaptation of difficulty) underscore that educators see AI's primary value as a powerful tool for dynamic differentiation. This aligns with modern pedagogical theory, which emphasizes personalized learning paths to optimize acquisition of receptive skills (Hattie & Timperley, 2021). The slightly lower agreement regarding the objectivity of AI feedback (P3, 60.4%) suggests that while teachers appreciate the efficiency of automated feedback, they maintain a degree of skepticism or belief in the irreplaceable value of human, qualitative assessment, particularly for younger learners.

2. The Readiness Gap (RQ2). The readiness results expose a significant gap that threatens to derail adoption, despite the enthusiasm. Only 54.2% of teachers feel adequately trained (R6). This near-even split highlights that approximately half of the teaching workforce is entering the AI era without the necessary technical skills or confidence. This finding is critical because perceived ease of use and self-efficacy are established as major predictors of technology adoption (Venkatesh et al., 2003). If teachers lack foundational training, the most sophisticated AI platforms will remain unused or misused, translating the high perceived potential (RQ1) into low realized benefits. Educational institutions must immediately prioritize targeted, practical professional development to bridge this skills deficit.

3. Overwhelming External Barriers (RQ3). The most striking finding of this study is the near-unanimous identification of external barriers, particularly infrastructural and ethical constraints. The agreement rate for Lack of reliable high-speed internet (R9) reached an alarming 95.8%. This infrastructural deficit represents an absolute, non-negotiable barrier, as AI-driven systems require constant cloud connectivity. Furthermore, the high level of concern regarding data privacy and security (R8) (89.6% agreement) demonstrates that teachers are acutely aware of the ethical and legal responsibilities associated with handling young students' sensitive data on external platforms. This is compounded by the substantial barrier of cost and lack of funding (R7) (77.1%). This confluence of infrastructure, ethics, and finance indicates that the problem of AI integration is fundamentally systemic, not psychological. The teachers are willing (high optimism, R10, 81.3%), but the systems are not ready.

4. Disparity Between Hope and Reality. The central theme emerging from the data is the pronounced disparity between teacher optimism and systemic capability. Teachers are highly motivated and believe in the promise of AI to enhance receptive skills instruction, but their enthusiasm is met by a reality defined by poor infrastructure (internet), insufficient professional support (training), and unresolved ethical dilemmas (data security). This paradox suggests that policy focus should immediately shift from promoting the *potential* of AI to investing in the *prerequisite conditions* necessary for effective and equitable implementation.

CONCLUSION

This study successfully investigated primary school English teachers' perceptions, readiness, and barriers to adopting AI-driven tools for customizing receptive skills instruction. The results clearly indicate that primary educators possess a strong and consistent belief in AI's capacity to solve the challenge of student heterogeneity by providing dynamic personalization. However, this optimism is severely constrained by three primary external factors: the near-total lack of ubiquitous high-speed internet access; major concerns regarding data privacy and security protocols; and a significant training gap among the teaching population. The findings lead to the following key recommendations for policymakers, administrators, and technology developers:

1. Prioritize Infrastructure: Educational funding must urgently be directed toward establishing high-speed, reliable internet infrastructure in all primary classrooms, as this is the foundational requirement (95.8% perceived barrier).
2. Establish Ethical Guidelines: Clear, mandatory, and transparent policies must be developed and communicated regarding the collection, storage, and use of young learners' data in AI systems to alleviate the high privacy concerns (89.6%).
3. Invest in Practical Training: Professional development should move beyond general awareness and focus on practical, hands-on, contextualized training that builds specific technical skills and confidence (addressing the 54.2% readiness rate).

By addressing these systemic barriers, educational stakeholders can ensure that the teachers' high enthusiasm for AI translates into equitable, effective, and ethical pedagogical

practice, ultimately fulfilling the promise of personalized learning for young English language learners.

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Баскетбол негіздері: допты беру және қағып алу (5-6 сыныптар) (Авторлық бағдарламаны тәжірибеде қолдану және зерттеу нәтижелері)

Торгаев Болат Ибрагимович

Түркістан облысы білім басқармасының Созақ ауданының білім бөлімінің «А.Байтұрсынов атындағы жалпы білім беретін мектеп» КММ, *Дене шынықтыру пәні мұғалімі*

Аңдатпа. Бұл әдістемелік мақалада 5-6 сынып оқушыларына баскетболдағы негізгі екі дағды – допты беру және қағып алу дағдыларын меңгертудің тиімді жолдары ұсынылады. Авторлық бағдарлама негізінде жүргізілген тәжірибелік сабақтар нәтижелері талданып, оқушылардың қозғалыс үйлесімділігі, дәлдік, шапшаңдық және командалық өзара әрекет дағдыларындағы өзгерістер көрсетіледі. Мақалада қолданылған педагогикалық технологиялар, жаттығулар жүйесі, бағалау тәсілдері және бағдарламаның тиімділігі жан-жақты сипатталады. Сонымен қатар дағдыларды қалыптастырудың кезеңдік моделі мен жас ерекшеліктеріне сай бейімделген жаттығулар кешені ұсынылады. Бағдарламаның жүйелі қолданылуы оқушылардың спорттық мотивациясын арттырып, олардың оқу үдерісіндегі белсенділігін күшейтетіні дәлелденді.

Түйінді сөздер: баскетбол, доп беру, доп қағып алу, дене шынықтыру, 5-6 сынып, әдістеме, авторлық бағдарлама.

Кіріспе

Бүгінгі дене шынықтыру пәні оқушылардың тек қимыл-қозғалыс дағдыларын қалыптастырумен шектелмейді. Ол тұлғаның жан-жақты дамуына, оның ішінде командалық жұмыс, стратегиялық ойлау, шыдамдылық, жауапкершілік, дене мәдениеті сияқты құндылықтарды қалыптастыруда ерекше рөл атқарады. Баскетбол – бұл аталған дағдыларды дамытатын тиімді спорттық ойындардың бірі. Әсіресе 5-6 сынып жасындағы оқушылар үшін допты беру және қағып алу дағдыларын меңгеру – ойынды толыққанды түсіну мен орындаудың алғашқы баспалдағы.

Зерттеулерге сүйенсек, қозғалыс дағдылары ерте жаста қалыптасқанда оқушылардың спорттық қызығушылығы тұрақты болады, ал дұрыс әдістемелерді қолдану олардың техникасын жақсартуға тікелей әсер етеді. Отандық және шетелдік әдебиеттерде (Smith J., 2019; Richards N., 2020; ҚР педагогикалық тәжірибелер жинағы, 2022) баскетбол техникасын үйретуде *көрнекілік, әрекет арқылы үйрену, жұптық және топтық жұмыстар, кезең-кезеңмен орындау* әдістерінің тиімділігі кеңінен сипатталады.

Алайда, көп еңбектерде бастауыш және орта буын оқушыларының жас ерекшеліктері, сабақта қауіпсіздік пен мотивацияны сақтау, динамикалық жүктемені дұрыс бөлу мәселелері жеткілікті деңгейде қарастырылмаған. Осыған байланысты 5-6 сыныптарға арналған авторлық бағдарлама құрастырылып, тәжірибеде тексерілді.

Мақаланың мақсаты – допты беру және қағып алу дағдыларын қалыптастыруға бағытталған авторлық бағдарламаның мазмұнын, қолданылу әдістерін және тиімділігін көрсету.

Міндеттері:

- баскетбол техникасының негізгі элементтерін оқыту әдістерін сипаттау;
- авторлық бағдарламаның құрылымын ашу;
- практика нәтижелерін талдау;
- әдістеменің артықшылықтары мен шектеулерін анықтау;
- педагогтерге практикалық ұсыныстар беру [1].

Әдістеме

Авторлық бағдарлама баскетболдағы «допты беру» және «допты қағып алу» дағдыларын 8 апталық оқу циклі арқылы үйретуге негізделді. Әдістеме үш негізгі қағидаға сүйенеді:

1. Қарапайымнан күрделіге өту;
2. Қайталау – дағдыны бекітудің негізгі тетігі;
3. Әр оқушының жеке ерекшеліктерін ескеру.

Бағдарламаның құрылымы

Апта	Мазмұны	Дағды бағыты
1-2	Негізгі тірек қалыптары, допты дұрыс ұстау	дайындық кезеңі
3-4	Кеудеден беру, екі қолмен беру	базалық дағдылар
5-6	Бір қолмен беру, жерге соғып беру	жетілдіру кезеңі
7	Қимыл барысында пас беру	қозғалыста орындау
8	Командалық жаттығулар, мини-ойындар	бекіту және ойынға қолдану

Қолданылған әдістер

1. Көрнекілік әдісі

Мұғалім техника элементтерін баяу, нақты көрсетіп, оқушылар оны қайталайды. Видеоқайталау да қолданылды.

2. Қимылдық жаттығуларды кезең-кезеңмен орындау

Техника үш бөлікте үйретілді:

1. Қолдың бастапқы қалпы
2. Пас беру техникасы
3. Қағып алу қозғалысы

3. Жұптық және топтық жұмыс

- ❖ Жұптық беру-қабылдау
- ❖ Үштік комбинация
- ❖ «Үшбұрыш» моделі бойынша пас алмасу

4. Ойын әдісі

Оқушылардың қызығушылығын арттыру үшін мини-ойындар енгізілді:

- ❖ «Кім дәл?»
- ❖ «Он пас»
- ❖ «Қорғаушыдан қаш»

5. Қауіпсіздік техникасы

Бағдарламаның міндетті бөлігі ретінде залдағы арақашықтық, соқтығысу қаупін азайту, дұрыс түсу техникасы үйретілді [2].

Практикада қолдану

Авторлық бағдарлама 5-6 сыныптарда 2 ай бойы апробациядан өтті. Сабақтар аптасына 2 реттен өткізілді. Тәжірибеге 48 оқушы қатысты. Нәтижелерді бақылау парақтары, видеоталдау және диагностикалық тапсырмалар арқылы бағалау жүргізілді.

1. Сабақ барысы

Әр сабақ үш кезеңнен тұрды:

1. Жылыту жаттығулары – 5-7 минут
2. Негізгі техника жаттығулары – 20-25 минут
3. Қорытынды және ойын бөлімі – 10 минут

2. Тәжірибелік жаттығулар үлгілері

Кесте 1. Жұптық жаттығулар жүйесі

Жаттығу	Мақсаты	Уақыты
Кеудеден пас	дәлдік	2 мин × 2
Бір қолмен пас	күш және бағыт	3 мин
Жерге соғып пас	қашықтыққа бағдарлау	2 мин
Қорғаушыға қарсы пас	тактикалық ойлау	4 мин

3. Диаграмма (нәтижені көрсету үлгісі)

Сабақ алдындағы және сабақтан кейінгі дәлдік көрсеткіші



4. Нәтижелерді талдау

Бағдарлама соңында келесі өзгерістер байқалды:

Көрсеткіш	Бастапқы деңгей	Қорытынды деңгей	Өсім
Пас дәлдігі	58%	87%	+29%
Қозғалыста пас беру	42%	76%	+34%
Қағып алу техникасы	61%	89%	+28%

Командалық әрекет	орташа	жоғары	–
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Талдау:

- Оқушылардың доппен өзара әрекеті жеңілдеді.
- Қозғалыс барысында пас беру сапасы айтарлықтай жақсарды.
- Қорғаушыға қарсы тұру, тактикалық шешімдер қабылдау қабілеті дамыды.
- Топтық мини-ойындар балалардың мотивациясын арттырды.



Артықшылықтары:

- ✓ Жүйелі түрде құрылуы
- ✓ Жас ерекшеліктеріне сай болуы
- ✓ Қызықты ойындар арқылы мотивацияны көтеруі
- ✓ Әр оқушыға жеке тапсырмалардың берілуі

Кемшіліктері:

- ✓ Спорт зал көлемі жеткіліксіз болғанда топтарға бөлу қажет
- ✓ Кей сабақтарда доп саны жетіспеуі ықтимал
- ✓ Уақыт аз болғанда қозғалыста пас беруді толық қамту қиындайды.

Ұсыныстар

1. **Жеке деңгейлік жаттығуларды көбейту.** Әр оқушының техникада қателіктері әртүрлі, сондықтан жеке диагностика жасау маңызды.
2. **Қосымша бейнематериалдар қолдану.** Оқушыларға кәсіби ойыншылардың пас беру техникасын көрсету – көнекілік әсерін арттырады.
3. **Қауіпсіздікке ерекше назар аудару.** 5-6 сынып жасы – қозғалыс үйлесімділігі толық қалыптаспаған кезең, сондықтан соқтығысу, жүгіріс бағытын бақылау маңызды.
4. **Ойын форматын жиі қолдану.** «Он пас», «Қорғаушыны алдау», «Тез пас» сияқты ойындар – техника мен тактиканы бірге үйретеді.
5. **Сабақ құрылымын үш деңгейде құру:**
 - ✓ базалық дағды
 - ✓ қозғалыста орындау
 - ✓ ойын барысында қолдану
6. **Қалыптастырушы бағалау түрлерін енгізу:**
 - ✓ чек-парақ

- ✓ өзін-өзі бағалау
- ✓ жұптық бағалау [3].

Қорытынды

Бұл әдістемелік мақалада 5-6 сынып оқушыларына баскетболдағы допты беру және қағып алу дағдыларын үйретуге арналған авторлық бағдарламаның мазмұны, құрылымы және оны практикада қолдану нәтижелері жан-жақты қарастырылды. Бағдарлама оқушылардың негізгі техникалық дағдыларын дамытуға, олардың қозғалыс дәлдігін арттыруға және командалық әрекет дағдыларын қалыптастыруға айтарлықтай әсер еткені анықталды. Әдістемеді қолданылған көрнекілік, жұптық жұмыс, ойын технологиялары, кезең-кезеңмен үйрету тәсілдері оқушылардың қызығушылығын арттырып, жаттығуларды жеңіл әрі түсінікті орындауға мүмкіндік берді.

Зерттеу нәтижелері көрсеткендей, дұрыс ұйымдастырылған жүйелі жаттығулар мен әдістемелік тәсілдер оқушылардың спорттық қабілеттерін ғана емес, сабаққа деген ынтасын да күшейтеді. Баскетболдың негізгі элементтері – пас беру мен допты қағып алуды сапалы меңгеру – болашақта оқушылардың күрделі ойын дағдыларын тез игеруіне жол ашады.

Ұсынылған әдістеме педагогтердің тәжірибесін байытып, дене шынықтыру сабақтарының тиімділігін арттыруға көмектеседі.

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Основы баскетбола: передача и ловля мяча (5-6 классы)

(Применение авторской программы на практике и результаты исследования)

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Аннотация. В данной методической статье представлены эффективные способы обучения учащихся 5-6 классов двум ключевым баскетбольным навыкам – передаче и ловле мяча. На основе авторской программы проанализированы результаты практических занятий, отражающие изменения в координации движений, точности, скорости и навыках командного взаимодействия учащихся. Подробно рассматриваются педагогические технологии, система упражнений, методы оценивания и общая результативность программы. Кроме того, предлагается поэтапная модель формирования данных навыков и

комплекс упражнений, адаптированных к возрастным особенностям школьников. Доказано, что систематическое применение программы повышает спортивную мотивацию учащихся и усиливает их активность в учебном процессе.

Ключевые слова: баскетбол, передача мяча, ловля мяча, физическая культура, 5-6 классы, методика, авторская программа.

Basketball fundamentals: passing and catching (Grades 5-6)
(Application of the author's program in practice and research results)

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Abstract. This methodological article presents effective ways to teach two key basketball skills—passing and catching the ball—to 5th–6th grade students. Based on the author's program, the results of practical lessons are analyzed, demonstrating improvements in students' movement coordination, accuracy, speed, and teamwork skills. The article provides a detailed description of the pedagogical technologies used, the system of exercises, assessment methods, and the overall effectiveness of the program. In addition, a step-by-step model for developing these skills and a set of exercises adapted to the age characteristics of learners are proposed. It has been proven that the systematic implementation of the program enhances students' sports motivation and increases their activity in the learning process.

Keywords: basketball, passing, catching, physical education, grades 5–6, methodology, author's program.

Ақша және қаржы сауаттылығы (3-сынып) (Авторлық бағдарламаны тәжірибеде қолдану және зерттеу нәтижелері)

Раметова Дана Досболовна

Жамбыл облысы Мойынқұм ауданы әкімдігінің білім бөлімі, «М. Әуезов атындағы орта мектеп» КММ, *Бастауыш сынып мұғалімі*

Аңдатпа. Бұл мақалада 3-сынып оқушыларына арналған «Ақша және қаржы сауаттылығы» атты авторлық бағдарламаны тәжірибеде қолдану нәтижелері талданады. Бағдарламаның негізгі мақсаты – бастауыш сынып оқушыларының қаржы мәдениетін қалыптастыру, ақша туралы алғашқы ұғымдарын кеңейту және күнделікті өмірде қарапайым қаржылық шешімдер қабылдауға үйрету. Мақалада бағдарламаны жүзеге асыру әдістемесі, сабақтағы практикалық тапсырмалар үлгілері, алынған нәтижелер мен тиімді әдістердің талдауы ұсынылады. Сонымен қатар зерттеу барысында оқушылардың қаржылық ойлау дағдыларының қалай өзгергені мен олардың жауапты тұтынушылық мінез-құлқының қалыптасуына әсері сипатталады. Бағдарламаның қолжетімділігі мен түрлі педагогикалық жағдайларға бейімделу мүмкіндіктері де көрсетіледі.

Түйінді сөздер: қаржы сауаттылығы, ақша, бастауыш сынып, функционалдық сауаттылық, үнемдеу, бюджет, авторлық бағдарлама, әдістеме.

Кіріспе

Қазіргі қоғамда әрбір адамның өмірінде қаржылық сауаттылықтың рөлі ерекше артып келеді. Экономикалық процестердің күрделенуі, цифрлық төлем жүйелерінің дамуы, жеке қаражатты тиімді басқару қажеттілігі балалардың қаржы мәдениетін ерте жастан қалыптастыруды талап етеді. Осыған байланысты бастауыш сынып деңгейінде қаржы сауаттылығының негіздерін оқыту – заман талабы.

3-сынып оқушылары үшін әзірленген «Ақша және қаржы сауаттылығы» атты авторлық бағдарлама олардың жас ерекшелігіне сай, түсінікті және күнделікті өмірмен тығыз байланыста болуын көздейді. Бала бұл жаста өзіне қажетті заттарды таңдауды, үнемдеу мен бюджетті жоспарлаудың қарапайым тәсілдерін меңгере бастайды. Сондықтан қаржы туралы білімді ерте кезеңнен беру олардың болашақта саналы шешім қабылдауына, қаржылық қателіктерден сақтануына және әлеуметтік жауапкершілігін арттыруға мүмкіндік береді.

Қазақстанда және әлемде қаржылық сауаттылықты ерте оқытуға арналған ғылыми еңбектер саны артып келеді. Мысалы, Нұрпейісова Т.Б. және Қайдаш И.Н. еңбектерінде цифрлық әлемдегі қаржылық және ақпараттық сауаттылықтың маңыздылығы атап өтілген. Отандық педагогтер тарапынан баланың қаржы мәдениетін тәрбиелеуде ойын әдістерінің, жобалық оқытудың тиімділігіне ерекше көңіл бөлінуде. Шетелдік тәжірибеде (OECD, Junior Achievement, Financial Kids Projects) қаржы сауаттылығы міндетті пән ретінде бастауыштан беріледі.

Мақаланың мақсаты – 3-сынып оқушыларына арналған авторлық бағдарламаның тиімділігін зерттеу, оны енгізудің әдістемесін сипаттау және оқу процесіне қолдану тәжірибесін талдау.

Міндеттері:

- бағдарлама мазмұны мен құрылымын таныстыру;
- қолданылған әдіс-тәсілдерді сипаттау;
- оқу процесіндегі нәтижелер мен өзгерістерді талдау;
- педагогтер үшін әдістемелік ұсыныстар әзірлеу [1].

Әдістеме

Авторлық бағдарламаның мазмұны оқушылардың жас ерекшелігіне сай қарапайым, түсінікті және ойын, тәжірибелік жұмыс арқылы меңгерілетіндей етіп құрылған.

Бағдарламаның негізгі тақырыптық бөлімдері:

1. Ақша деген не?
2. Ақшаның түрлері және цифрлық төлемдер;
3. Бюджет және жоспарлау;
4. Қажеттілік пен қалау;
5. Үнемдеу және қауіпсіздік;
6. Дүкендегі дұрыс таңдау;
7. Жауапты тұтынушы.

Бағдарламаның әдістемелік негіздері

1. Ойын технологиясы

Ойын элементтері (ролдік ойындар, қаржы пазлдары, тапсырмалары бар QR-квест, виртуалды дүкен) оқушылардың қызығушылығын арттырып, күрделі ұғымдарды жеңіл меңгеруге мүмкіндік берді.

Сабақтағы ойын үлгісі:

«Үнемде немесе жұмса?» ойынында балаларға 10 шартты «теңге» беріледі, олар ақша жұмсаудың түрлі жағдайлары бойынша шешім қабылдайды.

2. Жобалық оқыту әдісі

Оқушылар «Отбасылық мини-бюджет», «Арман жинақ сандығы» сияқты шағын жобаларды дайындады. Жоба барысында олар қаржылық мақсат қоюды, шығындарды топтастыруды, қаражатты жоспарлауды үйренеді.

3. Тәжірибелік жұмыс әдісі

Сыныпта «мини-дүкен», «банк терезесі», «төлем картасы макеті» сияқты практикалық орталар ұйымдастырылды.

Оқушылар тауар бағасын салыстырып, «ақша төлеп», «қолжетімді бюджетті жоспарлап» отырды.

4. Цифрлық технологияларды қолдану

- ❖ BilimLand тапсырмалары;
- ❖ Quizlet қаржылық терминдер карталары;
- ❖ Kahoot тесттері;
- ❖ Интерактивті диаграмма құрастыру құралдары.

5. Тұтынушылық мінез-құлықты қалыптастыру әдісі

Оқушылар жарнамаларды талдап, «Пайдалы сатып алу», «Қажетсіз шығындар» атты топтық пікірталастар жүргізді [2].

Практикада қолдану

Авторлық бағдарлама 8 апта ішінде 16 сабақ форматында жүргізілді. Әр сабақ нақты практикалық әрекетке негізделді.

1. «Ақша деген не?» сабағының мысалы

Оқушылар түрлі елдердің банкноталарын көріп, олардың айырмашылығын, тарихи тұлғаларды, цифрлық белгілерін талдады.

Сабақ соңында «Өз банкнотамды жасаймын» шығармашылық жұмысы орындалды.

Кесте 1. Сабақ мазмұнының құрылымы

Сабақ кезеңі	Мазмұны	Уақыты
Қызығушылық ояту	«Ақша қайдан пайда болды?» видеосы	5 мин
Мағынаны ашу	Шынайы банкноттарды талдау	15 мин
Тәжірибелік тапсырма	Өз банкнотамды құрастыру	15 мин
Рефлексия	«Мен бүгін білдім...»	5 мин

2. «Мини-дүкен» тәжірибелік жұмысы

Сынып ішінде 12 түрлі тауар қойылған дүкен ұйымдастырылды. Әр балаға 20 «оқу теңге» таратылды.

Олар өз қажеттілігіне қарай тауар таңдап, қаражатты үнемдеп, сатып алу парағын толтырды.

Таңдалған категориялар:

- Азық-түлік – 45%
- Ойыншық – 22%
- Кеңсе тауарлары – 18%
- Декоративті заттар – 15%

Оқушылардың көбі қажеттілікті дұрыс таңдап, ең маңызды заттарды таңдауға тырысқаны байқалды.



3. «Отбасылық бюджет» жобасы

Әр оқушыға шартты отбасының кірісі мен шығыны берілген карточка ұсынылды. Олар шығындарды төрт санатқа бөлді:

- Тұрмысқа қажетті;
- Оқу шығындары;
- Демалыс;
- Қажетсіз шығындар.

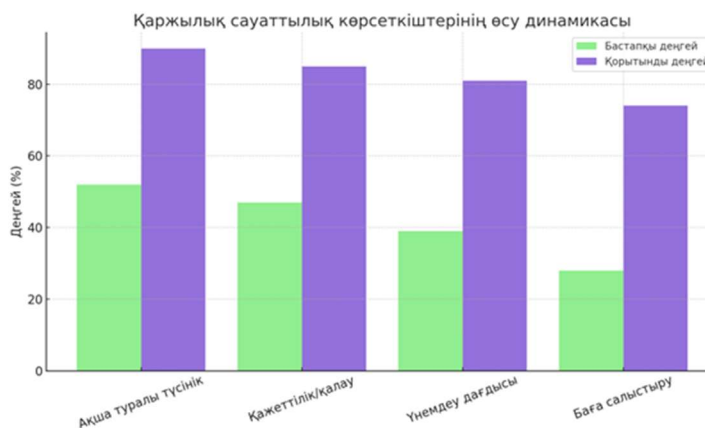
Кесте 2. Оқушылардың шығындарды топтастыру нәтижесі

Шығын атауы	Дұрыс топтастырған оқушылар (%)
Киім	86%
Ойыншық	92%
Тұрмыстық заттар	89%
Сладости	63%
Жол ақысы	78%

4. Нәтижелерді талдау

8 апта соңында тест, бақылау және рефлексия нәтижелері талданды.

Диаграмма 2. Қаржылық сауаттылық бойынша көрсеткіштің өсу динамикасы



Көрсеткіш	Бастапқы деңгей	Қорытынды деңгей
Ақша туралы базалық түсінік	52%	90%
Қажеттілік пен қаланы ажырату	47%	85%
Үнемдеу дағдылары	39%	81%
Баға салыстыру	28%	74%

Бағдарлама тиімділігінің дәлелдері:

- ✓ Оқушылар ақша туралы түсінігін нақтылап, сөздік қоры 2 есе артты.
- ✓ Сабаққа қызығушылық жоғары болды (92% оқушы «өте қызықты» деп бағалады).
- ✓ Ата-аналар үйдегі ақшаны жұмсауда баланың саналы пікір білдіре бастағанын атап өтті.
- ✓ Топтық жұмыс, логикалық тапсырмалар қаржылық ойлауды дамытты.

Кемшіліктері:

- ✓ Кейбір оқушылар үшін «бюджет жоспарлау» бөлімі күрделі болды.
- ✓ Цифрлық төлемдер туралы ақпаратты түсіндіруді жеңілдету қажет.
- ✓ Уақыт шектеулі болғандықтан, жеке жобаларды толық кеңейту мүмкін болмады.

Ұсыныстар

Авторлық бағдарламаны өз тәжірибесінде қолданғысы келетін педагогтерге төмендегі ұсыныстар беріледі:

1. **Көрнекілік пен практикалық орта жасаңыз.** Банкнот макеттері, дүкен бұрышы, ойын ақшалары, QR-төлем макеттері – балалардың түсінуін жеңілдетеді.
2. **Қаржылық терминдерді жас ерекшелігіне бейімдеңіз.** «Бюджет», «табыс», «шығын», «цифрлық төлем» сияқты терминдерді өмірмен байланыстырып түсіндіру қажет.
3. **Ата-аналарды үдерісқа қосыңыз.** Үйде кішігірім бюджет құру, қажеттілік пен қаланы талқылау – нәтиженің сақталуына әсер етеді.
4. **Ойын мен цифрлық құралдарды біріктіріңіз.** Kahoot, Wordwall, Quizlet секілді платформалар арқылы жылдам кері байланыс алуға болады.
5. **Бағалаудың әртүрлі әдістерін қолданыңыз.**
 - бақылау парақтары
 - мини-есептер
 - жобалық жұмыс
 - рефлексия күнделіктері.
6. **Бағдарламаны басқа пәндермен кіріктіріңіз.** Математикада – баға салыстыру, қазақ тілінде – сатып алу диалогтарын жазу, дүниетануда – еңбек және ақша туралы түсініктер [3].

Қорытынды

3-сынып оқушыларына қаржы сауаттылығын оқыту – олардың болашақта жауапты, саналы және экономикалық тұрғыдан ойлайтын тұлға болып қалыптасуына негіз қалайды. Авторлық бағдарламаны тәжірибеде қолдану барысында оқушылардың ақша туралы түсінігі кеңейіп, үнемдеу, жоспарлау және жауапты шығын жасау дағдыларын меңгергені анықталды. Практикалық жұмыстар, ойын технологиялары, цифрлық құралдар және жобалық тәсілдер бағдарламаның тиімділігін арттырды.

Зерттеу нәтижелері бастауыш сынып оқушыларының қаржы сауаттылығын дамыту мүмкін әрі қажетті екендігін дәлелдеді. Оқушылардың қызығушылығы, белсенділігі және білім сапасының артуы қолданылған әдістердің дұрыс таңдалғанын көрсетті.

Қаржы мәдениеті – тек экономикалық түсінік емес, бұл баланың тұлғалық дамуының маңызды бөлігі. Сондықтан мұндай бағдарламаларды мектеп тәжірибесіне кеңінен енгізу

оқушылардың функционалдық сауаттылығын арттыруға үлкен үлес қосады.

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Деньги и финансовая грамотность (3-класс)

(Применение авторской программы на практике и результаты исследования)

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Аннотация. В данной статье анализируются результаты применения авторской программы «Деньги и финансовая грамотность» для учащихся 3-класса. Основная цель программы – формирование финансовой культуры младших школьников, расширение их первоначальных представлений о деньгах и обучение принятию простых финансовых решений в повседневной жизни. В статье представлены методика реализации программы, примеры практических заданий на уроках, полученные результаты и анализ наиболее эффективных методов. Кроме того, описываются изменения в финансовом мышлении учащихся и влияние программы на формирование ответственного потребительского поведения. Также подчеркивается доступность программы и возможности её адаптации к различным педагогическим условиям.

Ключевые слова: финансовая грамотность, деньги, начальная школа, функциональная грамотность, экономия, бюджет, авторская программа, методика.

Money and financial literacy (Grade 3)

(Application of the author's program in practice and research results)

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Abstract. This article analyzes the results of implementing the author's program «Money and Financial Literacy» designed for 3rd-grade students. The main goal of the program is to cultivate financial culture among young learners, expand their initial understanding of money, and teach them to make simple financial decisions in everyday life. The article presents the methodology of program implementation, examples of practical classroom tasks, the outcomes obtained, and an

analysis of the most effective instructional methods. Additionally, the research describes how students' financial thinking has evolved and how the program contributed to the development of responsible consumer behavior. The article also highlights the accessibility of the program and its adaptability to diverse pedagogical contexts.

Keywords: financial literacy, money, primary school, functional literacy, saving, budget, author's program, methodology.

Technical Sciences

УДК 656.07:339.543(574)

СОСТОЯНИЕ ТРАНСПОРТНОЙ СИСТЕМЫ РЕСПУБЛИКИ КАЗАХСТАН И ВЛИЯНИЕ ТАМОЖЕННЫХ ОРГАНОВ НА МЕЖДУНАРОДНЫЕ ПЕРЕВОЗКИ ТОВАРОВ

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Аннотация: В статье рассматривается современное состояние транспортной системы Республики Казахстан и её роль в формировании международных транспортных коридоров в Евразийском регионе. Анализируются геополитические и экономические преимущества Казахстана как ключевого транзитного узла между Европой и странами Восточной и Юго-Восточной Азии, а также вклад транспортной инфраструктуры в повышение конкурентоспособности национальной экономики. Показано, что эффективное взаимодействие транспортной системы и таможенных органов является ключевым фактором успешной интеграции Казахстана в мировую транспортно-логистическую систему и повышения его транзитного потенциала.

Abstract: The article examines the current state of the transport system of the Republic of Kazakhstan and its role in the formation of international transport corridors in the Eurasian region. The article analyzes the geopolitical and economic advantages of Kazakhstan as a key transit hub between Europe and the countries of East and Southeast Asia, as well as the contribution of transport infrastructure to improving the competitiveness of the national economy. It is shown that effective interaction between the transport system and customs authorities is a key factor in Kazakhstan's successful integration into the global transport and logistics system and increasing its transit potential.

Ключевые слова: транспортная система; международные транспортные коридоры; транзитный потенциал; внешнеэкономическая деятельность; международные перевозки товаров; таможенные органы; таможенная политика; таможенное администрирование; таможенно-тарифное регулирование; экономическая интеграция; Евразийский экономический союз; транспортная инфраструктура; логистика; государственное регулирование внешней торговли.

Keywords: transport system; international transport corridors; transit potential; foreign economic activity; international transportation of goods; customs authorities; customs policy; customs

administration; customs and tariff regulation; economic integration; Eurasian Economic Union; transport infrastructure; logistics; state regulation of foreign trade.

Формирование мировой транспортной системы во многом определяется современными тенденциями совершенствования технологии перевозок и систем управления. Экономика Казахстана, расположенного в центре Евразийского континента, между емкими и динамично развивающимися рынками Европы, Восточной и Юго-Восточной Азии, зависит от эффективного использования потенциально высоких транзитных возможностей государства.

Республика Казахстан занимает ключевое положение с точки зрения обеспечения евроазиатских транспортно-экономических связей. Ее транспортные коммуникации связывают Китай и государства Центральной Азии с Российской Федерацией, Украиной и Европейским Союзом. В последние годы усиливается также интегрирующая роль Республики Казахстан на всем постсоветском пространстве. Республика Казахстан активно выступает за экономическую интеграцию в рамках ЕврАзЭС, включая создание Таможенного Союза и формирование единого транспортного пространства.

В качестве одного из важнейших приоритетов стратегического курса по вхождению Казахстана в число пятидесяти наиболее конкурентоспособных стран мира обозначено развитие транспортной инфраструктуры и услуг. Ставится задача – организовать внедрение конкурентной транспортной сети в региональный рынок для обеспечения лидирующих позиций республики в Центральной Азии.

Участие Казахстана в формировании международной транспортной системы приобретает особую актуальность в силу его геополитического положения, экономического потенциала и исторических традиций. На протяжении последнего ряда лет Казахстан демонстрирует высокие темпы экономического и социального развития среди стран постсоветского пространства.

За годы реализации Стратегии «Казахстан-2030» транспортная отрасль сделала значительный рывок в своем развитии, что способствовало ускоренному экономическому росту и ознаменовалось увеличением объемов перевозок грузов почти в три раза.

Стратегической задачей развития Казахстана до 2030 года является повышение эффективности и качества транспортных услуг при снижении транспортной составляющей в конечной цене товаров и услуг.

Относительно равнинный ландшафт и наличие больших запасов природного камня позволяют беспрепятственно развивать коммуникации железнодорожного и автомобильного транспорта.

Основная доля сети наземных путей сообщения Казахстана приходится на автомобильные и железные дороги (соответственно 88,4 и 14,0 тыс. км). Протяженность эксплуатируемых водных путей составляет 3,9 тыс. км, воздушных трасс – 61 тыс. км. Плотность транспортной сети на 1000 кв. км территории составляет: 5,1 км железных дорог, 32,4 км автомобильных дорог с твердым покрытием, 1,5 км внутренних водных путей. Схематично автомобильные дороги РК представлены на рисунке 1.

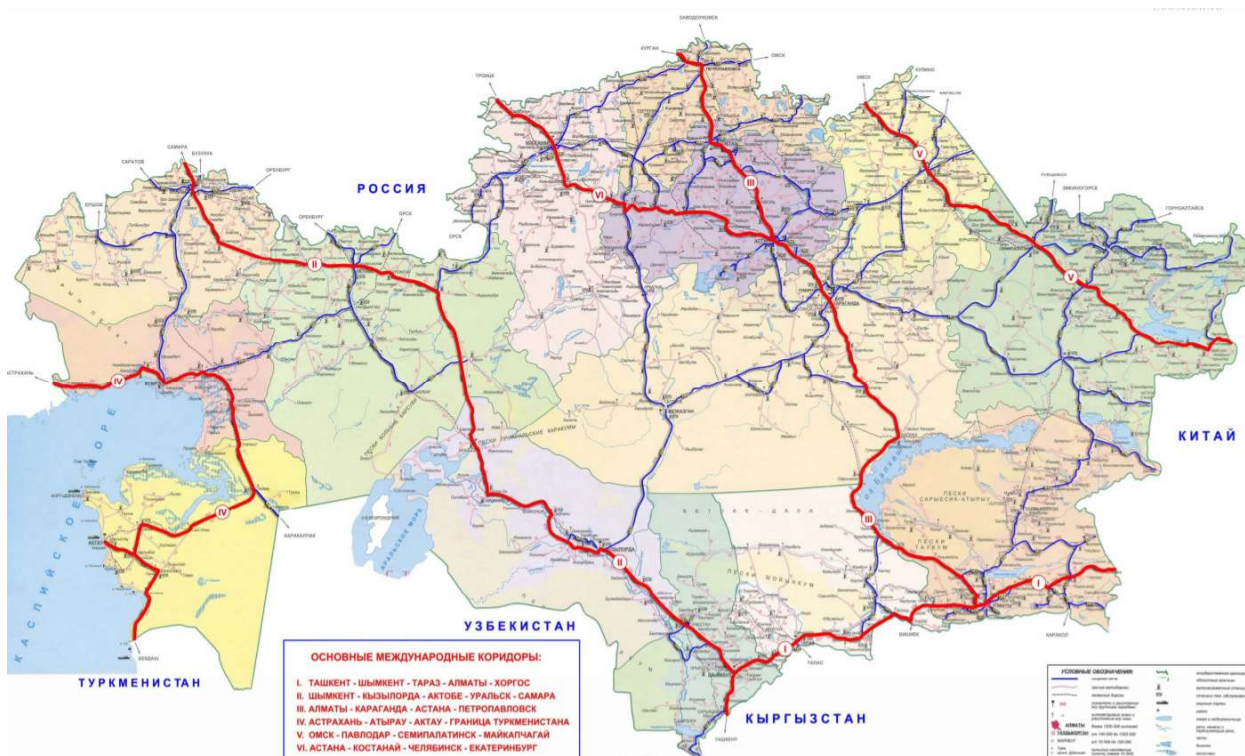


Рисунок 1. - Маршрут автомобильных дорог РК

В Казахстане реализуется национальная транспортная стратегия, рассчитанная на период до 2025 года которая входит в состав Стратегического плана развития до 2025 года, который, в свою очередь, является частью Третьей модернизации экономики. Главная цель до 2025 года — повышение конкурентоспособности экономики и благосостояния населения до уровня стран ОЭСР. Для этого необходимо развивать транспортную инфраструктуру страны в рамках более комплексного Национального инфраструктурного плана до 2029 года, который охватывает не только транспорт, но и энергетику, водоснабжение и цифровую инфраструктуру.

Главное преимущество наращивания транзитных перевозок через территорию Казахстана – это существенное сокращение расстояний. Даже при самых лучших условиях перевозок срок доставки грузов морским путем из Берлина в китайский порт Ляньюнган составляет 20 дней, железная дорога сокращает это время до 11 суток, расстояние транспортировки уменьшается вдвое.

Глобализация экономических процессов обуславливает необходимость организации международных транспортных коридоров для взаимовыгодной торговли между странами, обеспечения всем государствам, субъектам доступа к мировым транспортным коммуникациям. Для Казахстана исключительно важно войти в уже сложившуюся и отработанную систему перевозок в качестве незаменимого звена.

Современная концепция развития сети международных транспортных коридоров, проходящих через Казахстан, основывается на трех приоритетных направлениях:

- Россия, страны Европы и Балтии;
- Китай, Япония и страны Юго-Восточной Азии;
- республики Средней Азии и Закавказья, Иран и Турция.

В каждом из указанных направлений существуют сложившиеся международные транспортные коридоры, включающие комплекс наземных и водных магистралей. Они

имеют современное техническое оснащение и предназначены для концентрации в них международных транзитных перевозок.

Через территорию Казахстана проходят 6 железнодорожных, 6 автомобильных и 72 воздушных коридора. Особое место в системе транспортно-коммуникационного комплекса страны занимают два узла, расположенные на международных транспортных коридорах, – это железнодорожный переход «Дружба» на востоке и морской торговый порт Актау на западе страны.

Цель развития транспортного комплекса Республики Казахстан заключается в эффективной доставке отечественных экспортных товаров на внешний рынок и оказании широкого набора транспортных услуг их пользователям.

Таможенные органы в процессе своей деятельности неизбежно влияют на процесс осуществления международных перевозок товаров.

Ключевая цель деятельности таможенных органов – максимальное содействие международным экономическим отношениям, ускорение товарооборота, однако нельзя забывать о том, что таможенная служба исторически формировалась как государственный фискальный аппарат, основная задача которого – пополнение государственного бюджета. В настоящее время каждый третий налоговый тенге попадает в государственный бюджет из таможенных органов; путем разумных протекционистских мер таможенная служба оберегает национальную промышленность.

Как отмечают современные экономисты, особое место в обеспечении предпринимательской деятельности занимает оказание нерыночных бюджетных услуг, к которым относятся услуги таможенных органов. Качество предоставления таможенных услуг оказывает прямое воздействие на мощность и интенсивность проходящих через таможенную границу товаропотоков и на эффективность функционирования предпринимательства, осуществляющего внешнеэкономическую деятельность. При этом функционирование учреждений, оказывающих нерыночные бюджетные услуги, в силу ряда их специфических особенностей (монополия на предоставляемые услуги, слабая адаптивность и динамичность, строгая регламентация деятельности, низкая мотивация работников, бюрократизация и коррупция среди работников, опосредованная оценка потребителем эффективности предоставления нерыночных бюджетных услуг) недостаточно эффективно. Это не позволяет в полной мере удовлетворять потребность предпринимательских структур в таких услугах и препятствует нормальному осуществлению и развитию предпринимательской деятельности и национальной экономики в целом.

Глубокие, коренные по своей сущности политические и социально-экономические преобразования, осуществляемые в современном Казахстане, обусловили серьезное изменение роли и значения многих областей деятельности и сфер управления, составляющих фундамент жизни казахстанского общества. Среди таких направлений, значение которых особенно за последние годы постоянно возрастает, следует назвать таможенное дело, являющееся составной частью внешней и внутренней политики Республики Казахстан.

Таможенное дело по своему составу и структуре – явление сложное, многоплановое; оно имеет комплексный характер. Сфера таможенного дела представляет собой область государственного регулирования по применению таможенных действий при реализации таможенной политики Республики Казахстан. В Казахстане осуществляется единая таможенная политика, являющаяся составной частью внутренней и внешней политики Республики, и также относится к ведению центральных исполнительных органов Республики Казахстан в пределах их полномочий.

Вкратце опишем существующую организационную структуру управления в таможенных органах Республики Казахстан. Комитет таможенного контроля Министерств

финансов Республики Казахстан возглавляет председатель, назначаемый на должность и освобождаемый от должности Правительством Республики Казахстан. Председатель Комитета имеет заместителя (заместителей), назначаемых на должности и освобождаемых от должностей Правительством Республики Казахстан по представлению председателя. Председатель организует и руководит работой Комитета, несет персональную ответственность за выполнение возложенных на Комитет задач и осуществление им своих функций.

В настоящее время таможенными органами Казахстана занимается Комитет государственных доходов (КГД) Министерства финансов РК. Его структура включает центральные управления, такие как управление таможенного администрирования, таможенного контроля, таможенных операций и таможенного декларирования, а также другие департаменты, занимающиеся вопросами, связанными с таможенным регулированием. Обретение Казахстаном государственной независимости, провозглашение курса на формирование демократического общества с рыночной экономикой предопределили необходимость проведения широкомасштабных реформ. В этих условиях неизмеримо возрастает роль таможенных органов.

В настоящее время можно обосновать новую роль таможенной службы – превращение ее в реально действующий инструмент государственного регулирования внешнеторгового оборота, внешнеэкономической деятельности в целом, наполнения доходной части республиканского бюджета; новые приоритеты таможенного дела – перенос центра тяжести его осуществления на фискально-экономические и защитные составляющие; необходимость разработки и применения быстро выполняемых процедур таможенного оформления и контроля, максимального приближения их к участникам внешнеэкономической деятельности.

Таможенным органам как одному из базовых институтов экономики принадлежит важнейшая роль в деле обеспечения экономических интересов государства.

Участвуя в регулировании внешнеторгового оборота и осуществляя фискальную функцию, таможенная служба регулярно пополняет государственный бюджет и тем самым способствует решению экономических проблем.

Для определения наиболее существенных результатов, формирующих общий результат деятельности таможенных органов и влияние таможни на процессы международных перевозок товаров, функции таможенных органов можно классифицировать по направленности воздействия:

1) основные – связаны с осуществлением ВЭД и направлены на удовлетворение потребностей общества, в т.ч. предпринимательства, в таможенных услугах;

2) обеспечивающие – обеспечивают собственную деятельность и развитие.

Непосредственный результат деятельности таможенной службы достигается в ходе выполнения основных функций, которые, в свою очередь, можно классифицировать:

По объекту приложения:

1) производство таможенного оформления товаров;

2) проведение таможенного контроля;

3) начисление и взимание таможенных платежей и налогов;

4) контроль за правильностью исчисления и взимания таможенных платежей и налогов;

5) обеспечение соблюдения подчиненными должностными лицами законодательства при осуществлении таможенного оформления и таможенного контроля;

6) предотвращение случаев недостоверного декларирования товаров, контрабанды и иных нарушений таможенного законодательства;

7) контроль за деятельностью участников ВЭД и лиц, осуществляющих деятельность в области таможенного дела (склады временного хранения, таможенные брокеры и др.).

По обеспечению интересов сторон:

1) обеспечивают интересы предпринимательства (производство таможенного оформления, соблюдение должностными лицами законодательства и т.п.);

2) обеспечивают интересы государства (осуществление таможенного контроля, начисление и взимание таможенных платежей и налогов, борьба с недостоверным декларированием, контрабандой и иными нарушениями таможенных норм и правил, и т.п.).

При этом таможенные органы, осуществляя функции, обеспечивающие интересы государства, одновременно оказывают косвенное благоприятное воздействие на предпринимательскую деятельность, противодействуя теневому (незаконному) предпринимательству и обеспечивая равные условия для осуществления легальной предпринимательской деятельности.

Таким образом, основные функции таможенных органов сводятся к предоставлению услуг, которые по степени воздействия на предпринимательскую деятельность могут быть классифицированы на:

1) прямые услуги (определяют скорость и качество таможенного оформления перемещаемых через таможенную границу товаров);

2) косвенные услуги (направлены на обеспечение соблюдения таможенного законодательства всеми участниками ВЭД, проведение качественного таможенного контроля, борьбу с недостоверным декларированием и контрабандой).

Увеличение скорости проведения таможенного оформления перемещаемых товаров и снижение удельного веса незаконного предпринимательства положительно отразится на обеспечении ведомственных интересов таможенных органов, в частности на суммах таможенных платежей и налогов, перечисляемых в бюджет. В то же время, сосредоточение основных ресурсов таможенных органов на обеспечении ведомственных интересов, в том числе реализации фискальной функции, напротив, не обеспечит в полной мере удовлетворение предпринимательских структур в таможенных услугах. Кроме того, при оценке эффективности деятельности таможенных органов по сумме перечисляемых в бюджет таможенных платежей и налогов косвенно стимулируется импорт более дорогостоящих и, соответственно, налогоёмких товаров (готовой, высокотехнологичной продукции) и экспорт природных ресурсов, облагаемых вывозной таможенной пошлиной (суммы таможенных платежей от импорта сырья и дешевых товаров незначительны, равно как и от экспорта готовой продукции). Это противоречит проводимой государством политике поддержки отечественного производителя.

На основе классификации функций таможенных органов и предоставляемых таможенных услуг в структуре результата ее деятельности можно выделить два основных направления, в ходе реализации которых оказывается как прямое, так и косвенное воздействие на предпринимательскую деятельность, в том числе и на предпринимательскую деятельность в сфере перевозок товаров (в транспортной сфере):

– содействие внешней торговле;

– правоохранительная (проверочная) деятельность.

Одной из важнейших задач таможенной службы Республики Казахстан в сфере совершенствования таможенного администрирования является дальнейшая работа над таможенно-тарифным регулированием. Напомним, что таможенно-тарифное регулирование является методом государственного регулирования внешней торговли товарами, реализуемым путем применения ввозных и вывозных таможенных пошлин.

Таким образом Казахстан принимает активное участие в процессах интеграции. Очевидно и то, что в процессе перехода на более высокую ступень таможенного администрирования приходится совершенствовать и политику государства в сфере внешнеэкономической деятельности.

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BANK İNFRASTRUKTURUNDA MƏLUMATLARIN KONFİDENSİALLIĞI VƏ BÜTÖVLÜYÜ MEXANİZMLƏRİ

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XÜLASƏ

Bank sektorunda məlumatların tamlığının qorunması müştəri inamının təmin olunması və maliyyə əməliyyatlarının təhlükəsizliyinin önəmli şərtlərindən biridir. Bu məqalədə bank sistemlərində mütəmadi istifadə olunan şifrələmə üsulları — asimmetrik, simmetrik və hibrid kriptografiya yanaşmaları hərtərəfli təhlil olunur. Məlumat bütövlüyünün təminatı üçün elektron imzalar və kriptografik funksiyalarının tətbiqi öyrənilir. Eyni vaxtda, bank sektorunda məlumatların qorunması əsasında beynəlxalq standartlar, həmçinin ISO/IEC 27001 və PCI DSS kimi qaydalar nəzərdən keçirilir. Məqalədə təhlükəsizlik protokollarının tətbiqi ilə bağlı təcrübələr və real bank nümunələri müzakirə olunur. Nəticədə, səmərəli şifrələmə və tamlıq qoruma metodlarının bankların informasiya təhlükəsizliyində əhəmiyyətli rolu vurğulanır, gələcəkdə süni intellekt və kvant hesablama kimi yeni qabaqcıl texnologiyaların tətbiqinin vacibliyi qeyd edilir.

Açar sözlər: *informasiya təhlükəsizliyi, məxfilik, kibertəhdidlər, risk idarəetməsi, məlumatların şifrələnməsi, autentifikasiya, bütövlük, əlçatanlıq, rəqəmsal texnologiyalar, bank sistemləri*

GİRİŞ

İnformasiya texnologiyaların davamlı inkişafı və onların bank sistemlərinə əsaslı tətbiqi informasiya təhlükəsizliyi ilə bağlı məsələləri daha da ön plana çıxarmışdır. Müasir bankçılığın prioritet istiqamətləri — elektron ödəniş sistemləri, onlayn bankçılıq, mobil tətbiqlər və beynəlxalq maliyyə əməliyyatları — birbaşa rəqəmsal mühitdə fəaliyyət göstərir. Bu isə həm əməliyyatların əlçatanlığını və sürətini artırır, həm də müxtəlif yeni kibertəhdidlər və hücum növləri ilə müşayiət olunur.

Bank sektorunda istifadə olunan məlumatlar, adətən, yüksək səviyyədə həssas və məxfi xüsusiyyətlərə malikdir. Bu məlumatlara müştərilərin bank hesablarına dair məlumatlar, şəxsi məlumatları, kredit tarixçələri və əlavə önəmli informasiyalar daxildir. Belə məlumatların oğurlanması, modifikasiya edilməsi və ya silinməsi həm bankın nüfuzuna, həm də onun maliyyə dayanıqlığına əhəmiyyətli şəkildə təsir edə bilər. Bu səbəbdən, informasiya təhlükəsizliyinin təminatı üçün etibarlı texnoloji və hüquqi mexanizmlərin tətbiqi qaçınılmazdır.

Məlumatların mühafizəsi üç əsas prinsipə əsaslanır: məxfiliyin qorunması, bütövlüyün təmin olunması və əlçatanlığın saxlanması. Məxfilik, məlumatların yalnız icazəli şəxslər tərəfindən əldə olunmasını təmin edir. Bütövlük, məlumatların icazəsiz redaktə olunmasının və ya pozulmasının qarşısını alır. Əlçatanlıq isə məlumatlara tələb olunan anda fasiləsiz daxil olma imkanındır. Bu prinsiplərin təminatı bank sektorunun informasiya təhlükəsizliyi strategiyalarının təməli daşır.

Bu prinsiplər daxilində məlumatların şifrələnməsi əhəmiyyətli vasitə kimi ön plana çıxır. Şifrələmə məlumatların icazəsiz şəxslər tərəfindən oxunmasının qarşısını almaq üçün ən effektiv texnologiyalardan biridir. Müasir dövrün bank infrastrukturunda həm simmetrik açar şifrələməsi,

həm də asimmetrik açar şifrələməsi kimi üsullardan istifadə olunur. Hibrid metodlar isə bu üsulların üstünlüklərini özündə birləşdirərək daha səmərəli təhlükəsizlik həlli təqdim edir.

Bankların təhlükəsizlik strukturlarının qurulmasında PCI DSS, ISO/IEC 27001, NIST kimi beynəlxalq informasiya təhlükəsizliyi standartlarının rolu böyükdür. Bu standartlar, informasiya təhlükəsizliyinin təminatı üçün yalnız proqram təminatında istifadə olunan texniki metodları (məsələn, firewall-lar, antivirus proqramları) əhatə etmir. Paralel olaraq, təşkilati və inzibati tədbirləri də əhatə edir. Təşkilati tədbirlərə, məsələn, təhlükəsizlik siyasətlərinin hazırlanması, işçilərin təhlükəsizlik üzrə təlimatlandırılması daxildir. İnzibati tədbirlər isə məlumatların mühafizəsi üçün müəyyən edilmiş prosedurlar, qaydalar məsuliyyət bölgüsü və monitoring sistemlərinin qurulmasını nəzərdə tutur.

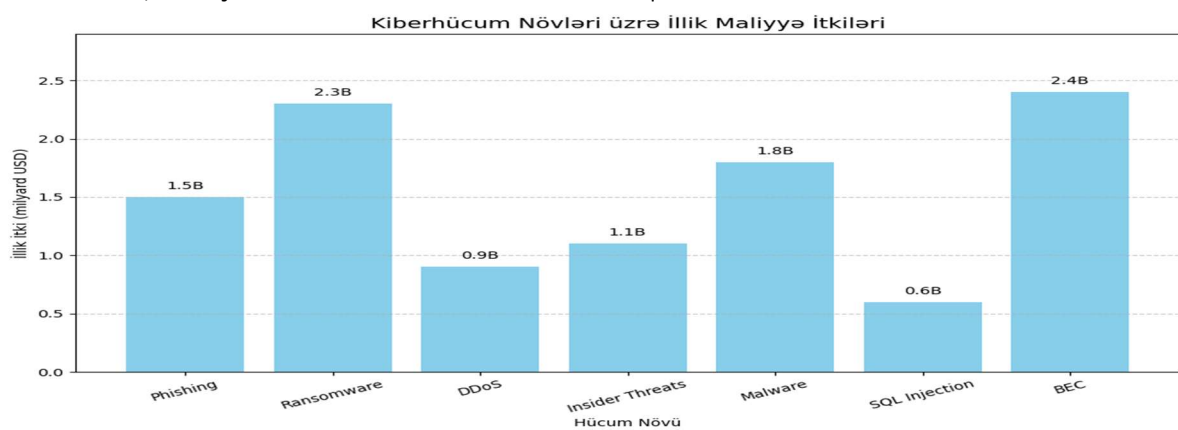
Bank sektorunda məlumat təhlükəsizliyinin əhəmiyyəti

İqtisadiyyatın təməl sütunlarından olan bank sektoru, böyük həcmdə maliyyə məlumatlarının idarə olunması və qorunması ilə məşğuldur. İnformasiya idarəetməsindəki boşluqlar zəruri maliyyə itkilərinə, hüquqi sanksiyalara və bankların imicinin zədələnməsinə səbəb ola bilər. Bu baxımdan, bank sektorunda informasiya təhlükəsizliyinin təminatı həm əməliyyat risklərinin azaldılması, həm də müştəri məmnuniyyətinin qorunması üçün əhəmiyyətlidir.

Məlumat adekvat qorunmaması bank sektorunda müxtəlif növ risklərin meydana çıxmasına zəmin yaradır :

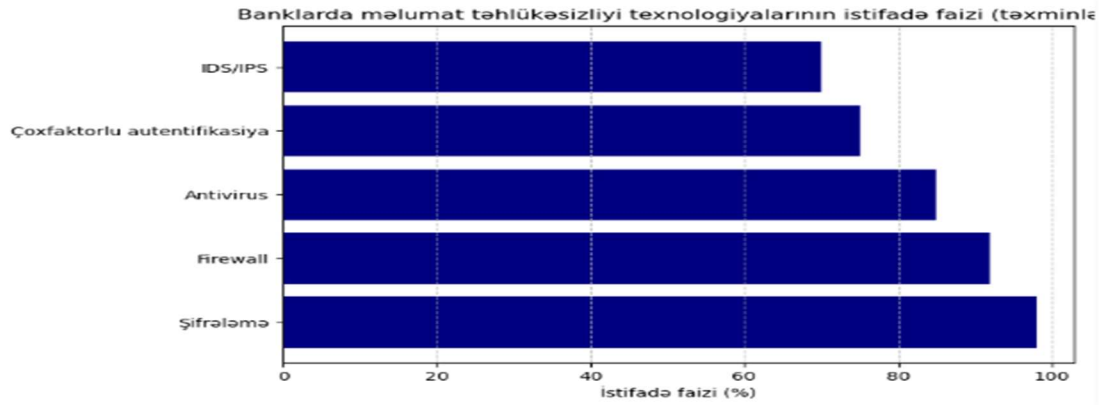
- **Məlumatların sızması:** Bank məlumatlarının kənar şəxslərə ötürülməsi nəticəsində mühüm maliyyə və nüfuz zərərləri yaranır.
- **Məlumatların modifikasiyası:** Hücumlar nəticəsində məlumatların zədələnməsi əməliyyatların səhv aparılmasına yol açır.
- **Xidmətin dayandırılması:** Kiberhücumlar bankın zəruri xidmətlərinin dayandırılmasına gətirib çıxara bilər ki, bu da istifadəçi narazılığına səbəb olur.
- **Hüquqi məsuliyyət və cərimələr:** Məlumatların qorunmaması qanunların pozulmasına səbəb olaraq bankların böyük maliyyə cərimələri və məhkəmə məsələləri ilə üzləşməsinə gətirib çıxara bilər.

Bank sistemlərində məlumat mühafizəsinin təmin edilməsi üçün şifrələmə alqoritmləri, autentifikasiya metodları, kibertəhdidlərin müəyyənləşdirilməsi və qarşısının alınması mexanizmləri, həmçinin davamlı analiz və monitoring vacibdir.

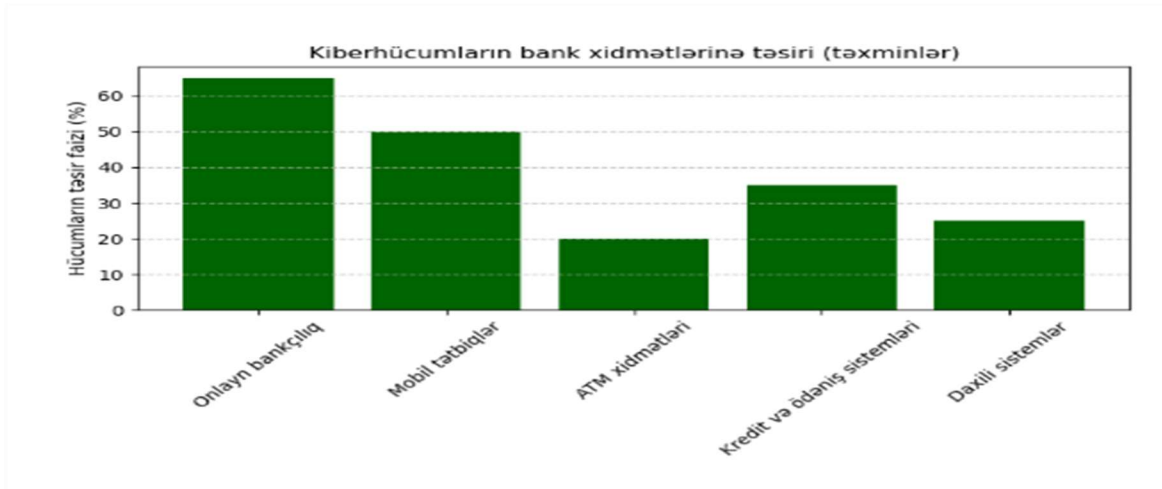


Şəkil 1. 2024-ci il üçün məlumat sızması nəticəsində yaranan maliyyə itkilərinin bölgüsü

Mənbə: Müəllif tərəfindən tərtib edilib.



Şəkil 2. Banklarda tətbiq olunan əsas təhlükəsizlik texnologiyalarının payı
Mənbə: Müəllif tərəfindən tərtib edilib.



Şəkil 3. Kiberhücumların təsir etdiyi əsas bank xidmətləri
Mənbə: Müəllif tərəfindən tərtib edilib.

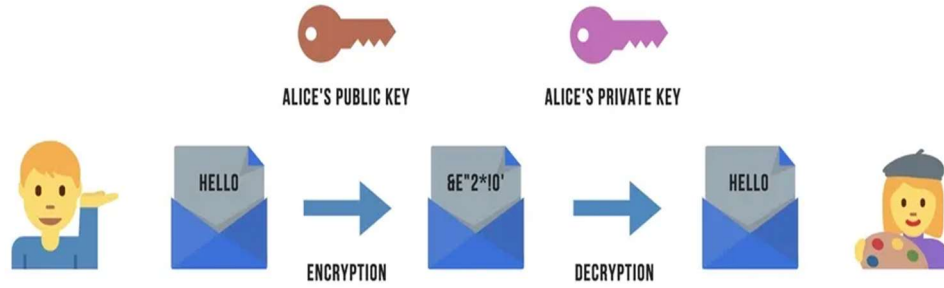
Məlumatların şifrələnməsi üsulları

1. Simmetrik açar şifrələmə (Symmetric Key Encryption)

Simmetrik şifrələmə metodunda məlumatların şifrələnməsi və deşifrələnməsi üçün eyni açardan istifadə olunur. Bu üsul həm sürətli, həm də əlverişlidir, amma açarın təhlükəsiz şəkildə ötürülməsi əsas problemlərdən biridir. Banklarda əsasən böyük həcmdə verilənlərin tez şifrələnməsi məqsədilə tətbiq olunur.

Ən məşhur simmetrik alqoritmlər:

- AES (Advanced Encryption Standard) — müasir dövrdə geniş istifadə edilmiş və etibarlı hesab olunan standartdır.
- DES (Data Encryption Standard) — müasir standartlara uyğun gəlmir və təhlükəsizlik baxımından zəif qəbul edilir.
- 3DES (Triple DES) — DES-in təkmilləşdirilmiş versiyasıdır.



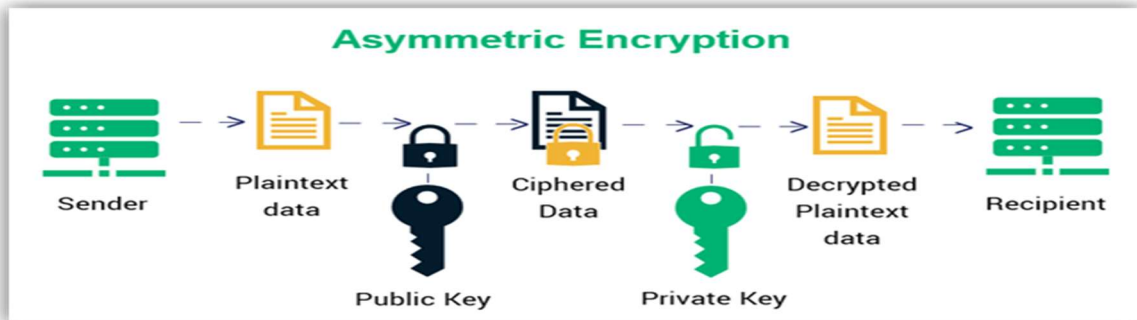
Şəkil 4. Simmetrik açar şifrələmə
Mənbə: Müəllif tərəfindən tərtib edilib.

2. Asimmetrik açar şifrələmə (Asymmetric Key Encryption)

Bu üsuldə məlumatların şifrələnməsi üçün açıq açar, deşifrələnməsi üçün isə gizli açar istifadə olunur. Açıq açar hər kəsə açıqlanır, gizli açar isə yalnız onun sahibinə məxsusdur və qorunur. Bu, məlumatların qorunaraq ötürülməsi və rəqəmsal imzaların hazırlanmasında ən çox istifadə olunan metoddur.

Ən məşhur asimmetrik alqoritmlər:

- RSA (Rivest-Shamir-Adleman) — ən çox istifadə olunan açar cütü əsasında şifrələmə alqritmi.
- ECC (Elliptic Curve Cryptography) — RSA-ya nəzərən daha kiçik açar ölçüsü ilə eyni dərəcədə təhlükəsizlik təmin edir.



Şəkil 5. Asimmetrik açar şifrələmə
Mənbə: Müəllif tərəfindən tərtib edilib.

3. Hibrid şifrələmə üsulları

Bank sistemlərində simmetrik və asimmetrik şifrələmə metodlarından birgə istifadə geniş yayılıb. Məsələn, məlumatlar AES ilə sürətli şəkildə şifrələnir, sonra AES açarı RSA ilə şifrələnərək təhlükəsiz şəkildə ötürülür. Bu üsul həm yüksək təhlükəsizlik, həm də effektiv fəaliyyət imkanı yaradır.

Məlumat bütövlüyünün qorunması üsulları

Məlumat bütövlüyü — məlumatların icazəsiz müdaxilələr olmadan doğru, tam və dəyişməz şəkildə saxlanmasını təmin edən təhlükəsizlik metodudur. Bank sektorunda bu yanaşma, xüsusilə maliyyə əməliyyatları, hesabatlar və müştəri məlumatlarının düzgün idarə olunması və ötürülməsi zamanı kritik rol oynayır.

Məlumat bütövlüyünün pozulması etimadsızlıq, hüquqi məsuliyyətlər və maliyyə itkiləri ilə nəticələnə bilər. Bu səbəbdən aşağıdakı üsullar geniş tətbiq olunur:

1. Hash funksiyaları

Daxil edilən məlumatı sabit ölçüdə, adətən qısa və unikal "hash" şəklində ifadə edən riyazi funksiyadır. Məsələn, ötürülən məlumatın və ya faylın hash dəyəri öncədən hesablanır və qəbul edən tərəfə ötürülür. Məlumatı alan tərəf hash dəyərini təkrar hesablayır və göndərilən hash dəyəri ilə müqayisə olunur. Əgər dəyərlər eynidirsə, məlumat dəyişdirilmədiyi anlamına gəlir.

2. Elektron imzalar

Bütövlüyü və müəllifliyi qoruyan rəqəmsal sənədlər üçün kriptografik mexanizmdir. O, fiziki imzanın elektron versiyası olub, sənədin dəyişdirilmədiyini və göndərən kimliyini təsdiqləyir. Elektron imzanın əsas funksiyaları :

- Müəllifliyi təsdiqi: İmza sənədin kim tərəfindən imzalandığını müəyyən edir və təsdiqləyir.
- Məlumat tamlığı: İmza sənədin dəyişdirilmədiyini göstərir.
- İnkaredilməzlik prinsipi: İmza sahibi, sənədi imzalamağı sonradan inkar edə bilməz.

Elektron imzanın işləmə prinsipi:

1. İstifadəçi imzalanacaq sənədin hash dəyərini hesablayır.
2. Hash onun özəl açarı ilə şifrələnir və elektron imza əldə olunur.
3. Qəbul edən şəxs hash dəyərini təkrar hesablayır və göndərilən açıq açarla imzanı yoxlayır.
4. Əgər uyğunluq varsa, imza təsdiqlənir.

Elektron imza növləri:

- Sadə elektron imza: Sadə elektron vasitələrlə yaradılan imzalar.
- Təkmil elektron imza: İstifadəçinin şəxsiyyətini müəyyən edən və sənədin bütövlüyü ilə bağlı imza növü.
- Qabaqcıl elektron imza: Təkmil imzanın əlavə təhlükəsizlik mexanizmləri ilə təchiz edilmiş formasıdır.

3. Məlumat inteqrasiya protokolları

Məlumatların paylaşılması zamanı onların tamlığını, etibarlığını və düzgünlüyünü təmin edən qayda və standartlar toplusudur. Bu protokollar məlumatların şəbəkə vasitəsilə dəyişdirilmədən və düzgün şəkildə çatdırılmasına zəmanət verir.

Populyar məlumat inteqrasiya protokolları :

- **TLS (Transport Layer Security):** İnternet vasitəsilə ötürülən məlumatların üçüncü tərəflər tərəfindən oxunmaması və dəyişdirilməməsi üçün istifadə olunur.
- **IPsec (Internet Protocol Security):** Şəbəkə səviyyəsində IP paketlərini şifrələyən və onların mənbəyinin düzgünlüyünü yoxlayan protokoldur.
- **HTTPS:** HTTP protokolu üzərində TLS istifadə edən təhlükəsizlik protokoludur.
- **S/MIME və PGP:** Mesajların məzmununu şifrələyir və elektron imza vasitəsilə göndəricinin kimliyini təsdiqləyir.
- **SOAP və REST protokollarında istifadə olunan təhlükəsizlik qatları:** XML və JSON əsaslı məlumatların inteqrasiyasında təhlükəsizliyi təmin edir.

Bank sektorunda şifrələmə və bütövlük tətbiqləri

Banklar fərqli şifrələmə metodları və məlumat tamlığının qorunması mexanizmləri tətbiq edirlər. Xüsusilə, bank kartları və mobil bank tətbiqləri, online bankçılıq kimi sahələrdə autentifikasiya və şifrələmə texnologiyaları önəmli rol oynayır. Bu bölmədə bank sistemlərində istifadə olunan vacib şifrələmə alqoritmlərinin və məlumat bütövlüyü təminatı üsullarının tətbiqləri öyrəniləcək.

1. Online bankçılıq və ödəniş sistemləri

İstifadəçi məlumatlarının təhlükəsizliyinin təmin edilməsi onlayn bankçılıqda ən mühüm məsələdir. Bu görə **SSL/TLS protokolları** geniş tətbiq olunur. TLS (Transport Layer Security) istifadəçi və bank serveri arasında şifrələnmiş əlaqə yaradır, nəticədə məlumatlar ötürülən zaman üçüncü şəxslər tərəfindən tutulub dəyişdirilə bilməz. Online ödəniş xidmətlərində əlavə təhlükəsizlik tədbirləri olaraq iki faktorlu autentifikasiya, tranzaksiya limitləri və əməliyyatların izlənməsi həyata keçirilir.

2. Bank kartları və EMV texnologiyası

Bank kartlarının təhlükəsizliyini artırmaq üçün EMV standartı (Europay, MasterCard, Visa) qəbul edilmişdir. EMV kartların işləmə prinsipi mikroçipə əsaslanır və kart məlumatlarının təhlükəsizliyini təmin etmək məqsədilə aşağıdakı üsullar tətbiq olunur:

- Kriptografik autentifikasiya: Kart və POS-terminal arasında şifrələnmiş kanal qurulur və hər əməliyyat üçün fərdi kriptografik imza yaradılır.
- PIN kod ilə təsdiq: Əməliyyatın təsdiqi üçün kart sahibi PIN kodunu daxil edir.
- Offline və online autentifikasiya: EMV həm offline (POS-terminalda), həm də online (bank serveri ilə) əməliyyatların qorunmasını təmin edən texnologiyadır.

3. Mobil bankçılıq və tətbiqlər

Mobil tətbiqlərdə aşağıdakı təhlükəsizlik mexanizmləri geniş tətbiq olunur:

- Şifrələmə: Mobil tətbiq ilə bank serveri arasındakı məlumat mübadiləsi TLS və digər şifrələmə texnologiyaları ilə təmin olunur.
- Biometrik autentifikasiya: Üz tanıma, barmaq izi və digər biometrik üsullar istifadəçinin kimliyini daha etibarlı şəkildə müəyyən edir.
- Token əsaslı autentifikasiya: Birdəfəlik istifadə üçün nəzərdə tutulmuş xüsusi kodlar (OTP) və ya hardware tokenlər tətbiq edilir.
- Təhlükəsizlik monitorinqi və anomaliyaların aşkarlanması: Şübhəli fəaliyyətlər və anormal giriş cəhdləri dərhal aşkar edilərək istifadəçiyə bildirilir.

Məlumatların qorunması üçün beynəlxalq standartlar və normativlər

Standartlar bankların informasiya təhlükəsizliyi siyasətinin formalaşmasına, risklərin minimuma endirilməsinə və məlumat itkisinin qarşısının alınmasına yardım edir. Aşağıda banklarda geniş tətbiq olunan normativlər və standartlar barədə məlumat veriləcək.

1. PCI DSS (Payment Card Industry Data Security Standard)

Ödəniş kartı məlumatlarının təhlükəsizliyini qorumaq üçün yaradılmış beynəlxalq standartdır və MasterCard, Visa, American Express, JCB və Discover kimi aparıcı kart şəbəkələrinin birgə əməkdaşlığı ilə ərsəyə gəlib.

PCI DSS tələbləri:

- Şəbəkə təhlükəsizliyinin təmin edilməsi.
- Kart məlumatlarının məxfiliyinin təmini üçün şifrələmə.
- Təhlükəsizlik zəifliklərinin müəyyənləşdirilməsi və müvafiq proqramların tətbiqi.
- İstifadəçi identifikasiyası və autentifikasiya mexanizmlərinin gücləndirilməsi.
- Davamlı monitorinq və auditin təşkili.

2. ISO/IEC 27001 və digər standartlar

İnformasiya təhlükəsizliyi idarəetmə sistemləri (İTİS) üçün beynəlxalq standartdır. Bu standart banklarda təhlükəsizlik tədbirlərinin planlaşdırılması, tətbiqi, nəzarəti və davamlı inkişafı üçün əsas rol oynayır.

ISO/IEC 27001-in əsas komponentləri:

- Məqsədlərin müəyyənləşdirilməsi.
- Risklərin analiz edilməsi və idarə olunması.
- Təhlükəsizlik üçün fiziki, texniki və inzibati tədbirlərin icrası.

- Davamlı izləmə və yoxlama.
- İşçilərin maarifləndirilməsi və təhlükəsizlik mədəniyyətinin gücləndirilməsi.

Nəticə

Bank sektorunda informasiya təhlükəsizliyi rəqəmsal texnologiyaların geniş tətbiqi ilə daha da vacib və mürəkkəb vəziyyətə gəlmişdir. Bankların idarə etdiyi müştəri məlumatları, maliyyə məlumatları və əməliyyat qeydləri yüksək dərəcədə həssas və gizli olduğundan, onların qorunması bankların nüfuzunu və fəaliyyətinin dayanıqlığını təmin etmək üçün vacibdir. Bankların informasiya təhlükəsizliyi siyasətinin başlanğıc prinsipləri informasiyaların məxfiliyi, bütövlüyü və əlçatanlığının təmin edilməsindən ibarətdir.

Bu məqsədlə bank sistemlərində asimmetrik və simmetrik açar şifrələməsi, hibrid şifrələmə daxil olmaqla, müxtəlif şifrələmə metodlarından istifadə edilir. Məlumat tamlığını təmin etmək üçün isə hash funksiyaları, təhlükəsizlik protokolları və elektron imzalar istifadə olunur. Həmçinin, bankların təhlükəsizlik sistemlərində həm inzibati, həm də texniki tədbirlər vacib əhəmiyyət kəsb edir. İşçilərin marifləndirilməsi, təhlükəsizlik standartlarının istifadəsi və davamlı monitoring kibercümlərin qarşısının alınmasında əsas rol oynayır.

PCI DSS və ISO/IEC 27001 kimi beynəlxalq standartlar bankların informasiya təhlükəsizliyi strategiyalarının təşkilində və əməliyyat risklərinin minimallaşdırılmasında əsas rol oynayır. Bu standartların tətbiqi qanunvericiliyə uyğunluğu təmin edir və müştəri məlumatlarının qorunmasını gücləndirir.

Nəticə etibarilə, informasiya təhlükəsizliyinin təmin olunması banklarda əməliyyatların etibarlılığını artırır, müştəri məmnuniyyətini yüksəldir və rəqabət qabiliyyətini gücləndirir. Bu sahədə texnoloji inkişaf və davamlı təkmilləşdirmələr isə bankların maliyyə dayanıqlığını və etibarını qorumaq baxımından vacibdir.

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МЕХАНИЗМЫ ОБЕСПЕЧЕНИЯ КОНФИДЕНЦИАЛЬНОСТИ И ЦЕЛОСТНОСТИ ДАННЫХ В БАНКОВСКОЙ ИНФРАСТРУКТУРЕ

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РЕЗЮМЕ

В банковском секторе защита целостности данных является одним из важных условий обеспечения доверия клиентов и безопасности финансовых транзакций. В данной статье всесторонне анализируются методы шифрования, регулярно используемые в банковских системах, – асимметричные, симметричные и гибридные криптографические подходы. Изучается применение электронных подписей и криптографических функций для обеспечения целостности данных. Также рассматриваются международные стандарты защиты данных в банковском секторе, а также такие нормативные акты, как ISO/IEC 27001 и PCI DSS. В статье рассматривается опыт и реальные примеры внедрения протоколов

безопасности в банках. В результате подчеркивается важная роль эффективных методов шифрования и защиты целостности в обеспечении информационной безопасности банков, а также отмечается важность применения новых передовых технологий, таких как искусственный интеллект и квантовые вычисления, в будущем.

Ключевые слова: *информационная безопасность, конфиденциальность, киберугрозы, управление рисками, шифрование данных, аутентификация, целостность, доступность, цифровые технологии, банковские системы*

DATA CONFIDENTIALITY AND INTEGRITY MECHANISMS IN BANKING INFRASTRUCTURE

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SUMMARY

In the banking sector, data integrity protection is one of the important conditions for ensuring customer trust and the security of financial transactions. This article comprehensively analyzes encryption methods regularly used in banking systems - asymmetric, symmetric and hybrid cryptography approaches. The application of electronic signatures and cryptographic functions to ensure data integrity is studied. At the same time, international standards based on data protection in the banking sector, as well as regulations such as ISO/IEC 27001 and PCI DSS, are reviewed. The article discusses experiences and real bank examples related to the implementation of security protocols. As a result, the important role of effective encryption and integrity protection methods in the information security of banks is emphasized, and the importance of applying new advanced technologies such as artificial intelligence and quantum computing in the future is noted.

Keywords: *information security, privacy, cyber threats, risk management, data encryption, authentication, integrity, accessibility, digital technologies, banking systems*

ARCHITECTURAL SOLUTIONS AND UX DESIGN PRINCIPLES OF CONCEPTUAL DESIGNS FOR IMPROVING THE EFFECTIVENESS OF EDUCATIONAL SMART TECHNOLOGIES

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Abstract

In the context of the rapid development of the digital economy, educational platforms are no longer merely venues for hosting content. Today, they function as autonomous ecosystems that provide adaptive learning, data collection, visual analytics, and support for individualized learning pathways. The quality of the system's design directly influences learners' motivation, pace of knowledge acquisition, and overall academic success. In recent years, there has been growing interest in the development of educational platforms that integrate SMART technologies with robust pedagogical logic. However, in practice, many solutions are limited either to a visual interface or to the technological component, neglecting the need for a holistic approach. This study examines the development of a design concept for an educational web application, where design, architecture, and pedagogical functionality are considered as mutually interdependent elements.

Keywords: educational technologies, SMART platforms, UX design, architectural solutions, adaptive learning, personalized learning pathways, pedagogical functionality, web application design.

1 Introduction

A fundamental principle in the design of contemporary educational Smart applications is the minimization of extraneous cognitive load on learners. John Sweller [1] emphasized that the interface, lesson structure, and information presentation should support the learner's comprehension rather than obstruct it. Empirical studies have shown that a poorly organized learning environment can compel users to expend up to forty percent of their cognitive capacity merely on locating essential information, detracting from engagement with the instructional content [2]. This challenge is particularly pronounced in IT education, where the inherent complexity of programming tasks demands sustained concentration, and excessive visual or informational load may result in learner demotivation and cognitive fatigue.

The internet offers a vast array of courses on design, programming languages, application architecture, and many other topics; however, domestically developed Smart educational products remain extremely limited. Within the framework of a research project conducted at Karaganda University of Kazpotrebsoyuz, a domestic educational platform, Flow, was developed, focusing on the integration of SMART technologies into the learning process. The platform provides comprehensive training designed to prepare learners for participation in a rapidly evolving industry.

The system is built around the concept of «flow» a state of deep engagement described by Mihaly Csikszentmihalyi [3]. Achieving this state requires a precise balance of task complexity, clarity of structure, and timely feedback. Consequently, the platform interface must be transparent, predictable, and emotionally neutral, ensuring that it does not distract from learning activities. Pedagogical principles, therefore, underpin practical recommendations for designing the learning tools, guiding parameters such as the size of individual components, methods for emphasizing critical information, the dynamics of user interaction, and the placement of control elements.

The development of a modern educational platform involves the analysis of user interactions and the subsequent formulation of corresponding usage scenarios. At the initial design stage, a comprehensive data collection process was conducted through surveys of students pursuing technical education. The results enabled the identification of several persistent user behavior patterns. Among the most frequently reported issues were a loss of orientation within the course due to the absence of a clear understanding of the user's current location, insufficient comprehension of the overall structure of the offered learning program, difficulties navigating between individual topics, perception of excessive visual elements, and a lack of timely feedback [4].

Based on these findings, a user journey model was developed, structured as follows Course Catalog → Registration → Personal Account → Lesson → Assessment → Analytics. Based on the obtained data, specific functional requirements were identified for each stage of user interaction with the system. The table below presents a comparative overview, illustrating the relationship between the defined requirements and the implemented design solutions.

Table 1. Correlation between user problems and design solutions

Observed problem	Interface requirement	Design solution
Loss of orientation within the course	Predictable navigation	Side lesson structure, progress indicator
Visual overload	Minimization of cognitive «noise»	Dark theme, emphasis using one to two colors
Difficulty finding materials	Quick access to required section	Central control panel with status blocks
Low motivation	Visualization of results	Graphs, lesson history, streak metric
Uneven learning pace	Adaptivity	Personalized recommendations

The data presented in the table demonstrate that every visual or structural element is a direct consequence of pedagogical logic and user scenarios, rather than a reflection of current design trends. The structural organization of the web application plays a fundamental role in ensuring the adaptability of the educational platform. During the development of this platform, the architecture was designed according to the principle of modularity, whereby each system component must possess autonomy, stability, and the capability for seamless expansion. As a result, the system comprises several core modules, closely integrated with one another:

- User Profile – contains information about user credentials, course progress history, and personalized settings.
- Course Catalog – represents a dynamic structure capable of adapting according to the user’s preferences.
- Lesson Module – serves as the core of the platform, supporting various types of content, including textual materials, images, code snippets, and interactive tasks.
- Analytics Module – collects statistical data on time spent studying materials, error rates, and navigation patterns between sections.
- Recommendation Subsystem – analyzes user activity and provides suggestions for materials appropriate to the learner’s level of preparation.

This mechanism ensures the system’s adaptability to the needs of each individual user, enabling the creation of a personalized learning pathway.

The objectives of developing the educational platform included the creation of a visual environment that combines professionalism, technological sophistication, and emotional neutrality. To achieve this, a comparative analysis of three design concepts was conducted: a light theme, a dark minimalist palette, and a vivid neon style.

Table 2. Comparison of three design concepts

Criterion	Light theme	Neon style	Dark technological palette
Level of visual noise	Medium	High	Low
Eye fatigue	Increased during prolonged use	High	Minimal
Support for concentration	Moderate	Low	High
Professional perception	Medium	Low	High
Compatibility with analytical visualizations	Moderate	Challenging	Excellent

The analysis revealed that the dark, technologically oriented theme provides the highest pedagogical and UX effectiveness. Deep indigo and violet tones form the foundation of the design, contributing to a reduction in visual fatigue and fostering a sense of full user immersion. To highlight key elements such as control buttons, task progress indicators, and the current section, a subtle coral-pink accent is applied exclusively to denote functional components. This approach enables a clear structuring of information, directing the user’s attention precisely to interactive areas while minimizing potential distractions.

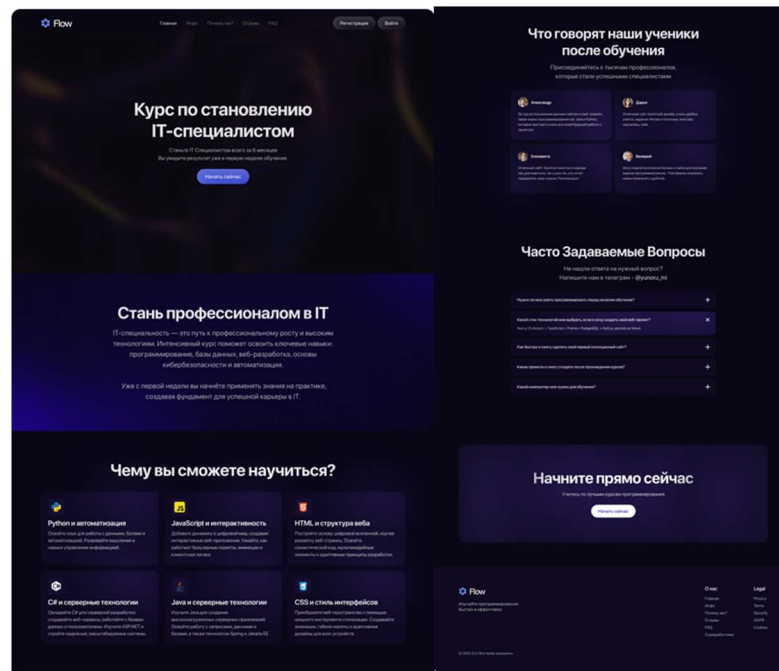


Figure 1 – Platform design styling

The lesson screen, serving as the central element of the system, was designed as the learner’s primary workspace. It incorporates a structure that supports the concept of continuous progression: the lesson map is positioned on the left, the theoretical content occupies the central area, and navigation to the next topic is placed at the bottom. This composition minimizes the number of decision points, which, according to cognitive psychology research, reduces the likelihood of cognitive overload and burnout when engaging with complex textual material [5].

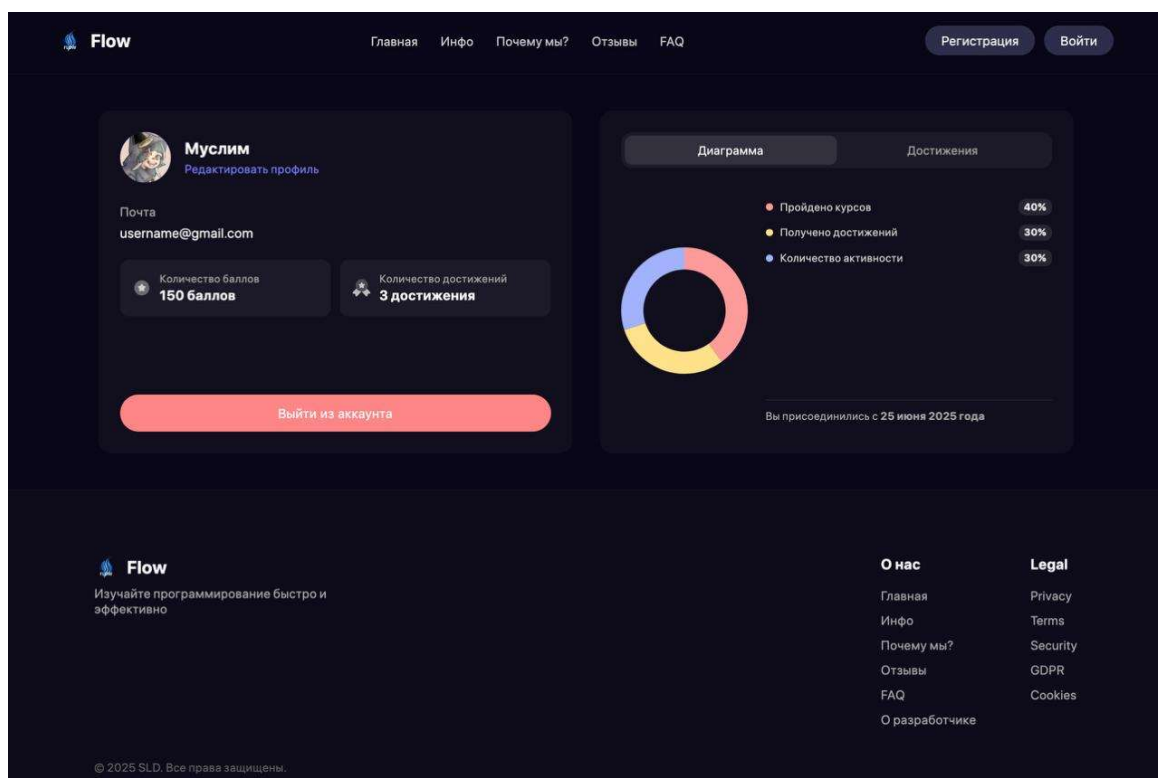


Figure 2 – Application structure

An important design decision was the support of various content types, including code snippets, visual diagrams, concise theoretical blocks, and interactive elements. The combination

of longer and shorter formats creates a natural learning rhythm, which positively influences attention retention while maintaining the overall concept of conciseness. The user’s personal account became a key component of the developed platform, designed according to the principle of providing complete control over the learning process. In the context of contemporary trends in digital education, this approach represents not merely an interface element, but a tool for self-regulation, enabling students to effectively plan their study schedules, monitor progress, and consolidate valuable learning practices [6].

The central component of the personal account interface is an informative profile block that accumulates essential information, including the current course completion status, a chronological record of activities, and a brief overview of recent lessons. Below this block is an organized list of available lessons, each clearly marked with a completion status. This system of visualizing statuses such as “in progress”, “awaiting assessment”, and “completed” minimizes potential confusion and helps users understand not only their current situation but also the scope of remaining work.

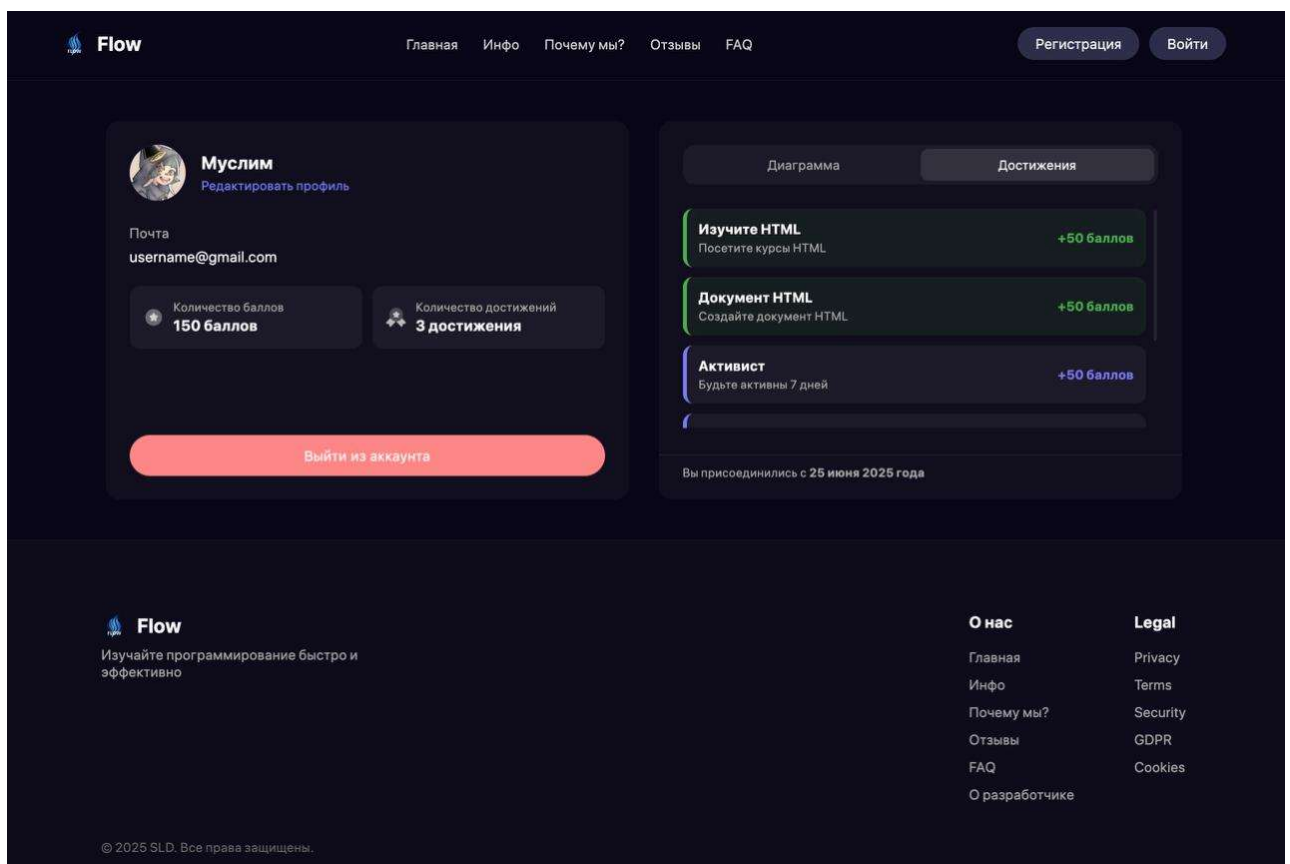


Figure 3 – User personal account

A key structural decision was the integration of a dashboard panel, which displays the percentage of program completion, the total time spent within the system, and a record of consecutive days of platform activity. Special attention was paid to ensuring that users could resume learning at any moment; consequently, the “Continue” button is positioned in a location of immediate access. This design choice aligns with the principles of minimizing cognitive load, as users do not need to search for the appropriate lesson or recall the point at which their learning was interrupted. Thus, the personal account functions not merely as a navigation tool but serves as the central hub of the entire educational experience—a space where pedagogical logic, progress analytics, and modern UX design principles converge [7]. As a result, the user receives

not just a set of features but a thoughtfully designed system for managing their own learning process.

The course catalog occupies a prominent place in the structure of the educational platform, as it is the starting point for most users in forming their individualized learning pathways. With the increasing number of available educational programs, the primary objective became the creation of an interface that not only provides information but also facilitates comparison, enabling users to make informed and deliberate decisions regarding their learning journey.

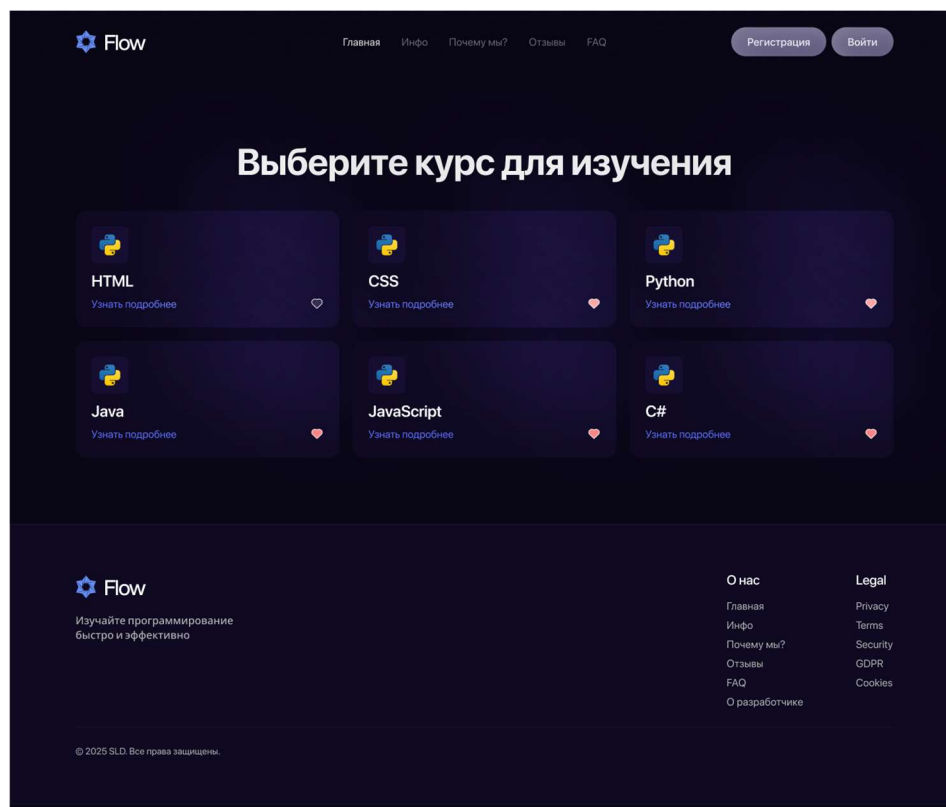


Figure 4 – Course catalog

The catalog interface was designed as an efficient navigation tool, providing simultaneous visibility of all content while avoiding information overload. The structural foundation is a grid of cards, each representing an individual course. Each card contains the essential minimum information: the course title, a brief description, difficulty level, and approximate duration. These parameters reflect the primary criteria students use when selecting educational products.

The overall composition of the screen, including the placement of the footer, is organized to allow the user to complete browsing the catalog while still having access to supplementary information and additional navigational elements. This design choice also adheres to the principle of interface predictability, ensuring that the structural layout remains consistent from page to page. Thus, the course catalog functions not merely as a showcase of educational products but as a tool for interacting with information. Its design embodies a combination of UX principles, pedagogical logic, and visual ergonomics, enabling the user to focus on selecting an appropriate learning pathway without unnecessary cognitive effort.

The lesson page constitutes the central element of the educational platform, as it is the primary space where theoretical material and practical examples are assimilated. The design objective was to create a stable educational environment in which the interface does not compete with the content but rather supports it. Achieving this required not only visual restraint in design but also careful architectural planning. The page structure follows the principle of minimal effort for navigation. A side panel is positioned on the left, providing access to the module's table of

contents and allowing the user to move instantly between sections of the course. Furthermore, this structural arrangement prevents context loss, which is a common issue in online learning, particularly when studying technical disciplines.

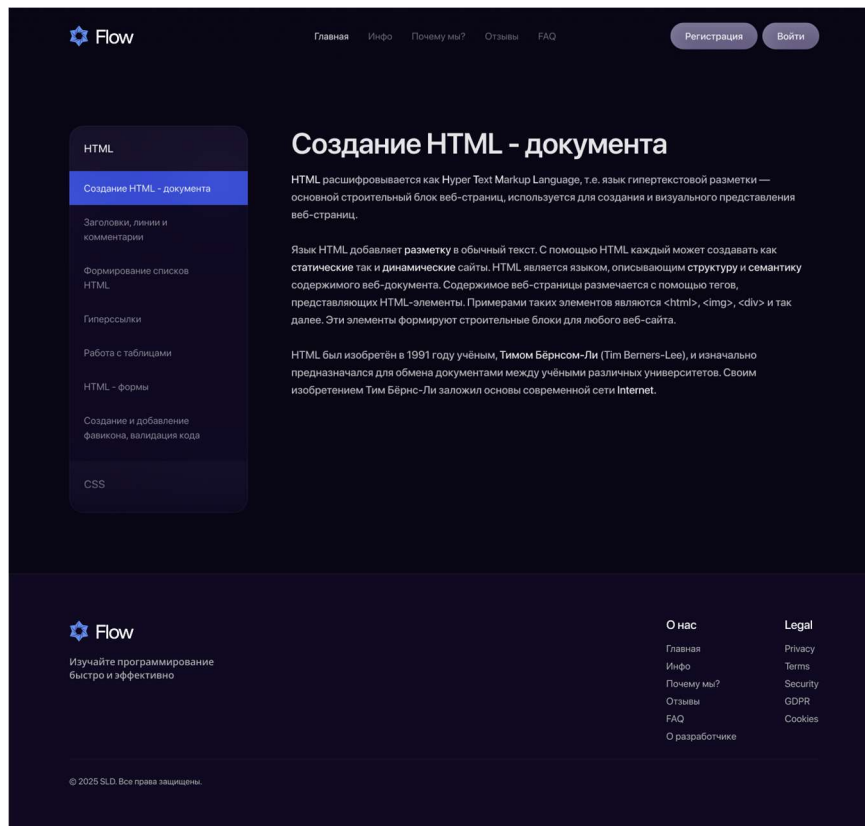


Figure 5 – Lesson page

The central area of the lesson page serves as the main educational zone, designed for reading and engaging with instructional materials. It includes the topic heading, a structured theoretical text, and embedded visualization elements such as code snippets, diagrams, images, and other multimedia inserts. This format supports diverse cognitive learning strategies, ranging from sequential reading to visual processing. When necessary, users can seamlessly switch between the content and the lesson structure without losing focus, which positively influences attention retention and the comprehension of complex concepts. The lower section of the page contains pagination controls and metadata, including estimated completion time and lesson status. Their placement at the bottom ensures a logical closure for each section and establishes a familiar navigational path throughout the course.

In developing the user interface of the platform, the foundations of web development using HTML and CSS were incorporated, driven by several considerations. Primarily, the web application format ensures cross-platform accessibility, allowing users to access the educational environment from any device without the need for additional software installation. HTML was chosen as the main tool for structuring content, enabling the creation of a logical hierarchy of learning modules, highlighting essential lesson components, and accurately displaying code snippets and multimedia elements. CSS served as the principal instrument for visual styling, providing both the overall platform aesthetic and specific interface solutions: the color accent system, adaptive typography, card styling, interactive button states, and layouts for the catalog, user profile, and lesson pages. The use of modern CSS functionalities, such as Flexbox, Grid Layout, custom properties, and media queries, facilitated the creation of a robust and adaptive design, ensuring correct rendering across a wide range of screen sizes and devices.

The educational platform underwent multiple cycles of UX testing with participation from first- and second-year students enrolled in the 06130100 Software Engineering program. During these studies, parameters such as the time required to locate necessary materials, the frequency of navigation errors, subjective user impressions of usability, and the level of cognitive load were carefully recorded.

Conclusion

The collected data indicate a substantial improvement in platform efficiency. For instance, the time spent moving between course sections was reduced by 34%, the number of navigation errors decreased by 22%, and the System Usability Scale score reached 82 out of 100, classified as «excellent». Participants also reported a noticeable reduction in visual fatigue after prolonged study sessions lasting 45–60 minutes. These findings suggest that the proposed design model positively impacts not only the aesthetics of information presentation but also produces tangible improvements in the learning process. Implementing a design concept for an intelligent educational system is a complex and systematic process underpinned by scientific evidence rather than a mere collection of isolated visual solutions. The effective performance of the interface, the well-considered structure of the application, the pedagogical logic of content delivery, the harmonized color scheme, and the tools for performance analytics must function interdependently.

Preliminary research confirms that high-quality user experience design significantly enhances learning outcomes, creates an environment conducive to achieving an optimal state of engagement, and minimizes cognitive load for learners. The developed concept convincingly demonstrates the potential of a modern web platform not only as a channel for knowledge dissemination but also as a tool for fostering professional competencies, promoting learner autonomy, and sustaining consistent educational motivation.

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Балқаш көлі деңгейінің 2000-2009 жылдар аралығындағы өзгерістерін математикалық модельдеу және болжау

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Аннотация. Бұл зерттеу Жетісу өңіріндегі Балқаш көлінің деңгейінің 2000-2009 жылдар аралығындағы айлық өзгерістерін жан-жақты талдауға және математикалық модельдеуге арналған. Зерттеу 2-кестеде келтірілген деректер негізінде жүргізілді. Жұмыс барысында уақыттық қатарлардың статистикалық талдауы орындалып, сызықтық регрессиялық модель құрылды. Алынған модель көл деңгейінің тұрақты төмендеу тенденциясын анықтауға мүмкіндік берді: әрбір ай сайын орташа есеппен 0,423 мБС-ге төмендеу. Модельдің детерминация коэффициенті ($R^2 = 0,75$) оның жеткілікті дәлдігін көрсетті. Зерттеу нәтижелері су ресурстарын басқару, экологиялық мониторинг және болжамдар жасау мақсатында пайдаланылуы мүмкін.

Түйінді сөздер: Балқаш көлі, көл деңгейі, математикалық модель, уақыттық қатар, сызықтық регрессия, болжам, статистикалық талдау, гидрология.

Кіріспе Балқаш көлі - Қазақстанның шөлді аймағындағы ең үлкен су қоймасы болып табылады және бүкіл аймақтың экологиялық, экономикалық және әлеуметтік тұрақтылығы үшін шешуші рөл атқарады. Көлдің экожүйесі ондаған балық түрлеріне, құстарға және сүөсімдіктеріне мекен етіп, жергілікті халықтың дәстүрлі тіршілік әрекеттерінің негізі болып табылады. Соңғы онжылдықтарда климаттың өзгеруі, жауын-шашын режимінің бұзылуы және антропогендік факторлардың күшеюі салдарынан көл деңгейінің өзгеруі ғылыми зерттеулердің басты нысанына айналып отыр.

Балқаш көлінің деңгейінің төмендеуі тек экологиялық мәселе ғана емес, сонымен қатар экономикалық және әлеуметтік мәселелерді тудыруы мүмкін. Көл деңгейінің төмендеуі балық шаруашылығына, сумен жабдықтауға, ауыл шаруашылығына және туризмге теріс әсер етеді. Осыған байланысты көл деңгейінің динамикасын зерттеу және оның болашақтағы мәнін болжау өзекті мәселе болып табылады.

Бұл жұмыстың мақсаты - Балқаш көлінің 2000-2009 жылдар аралығындағы деңгей өзгерістерін жан-жақты талдау және оған негізделген математикалық модель құру. Зерттеудің нақты міндеттеріне мыналар жатады: деректерді статистикалық өңдеу, негізгі тенденцияларды анықтау, регрессиялық модель құру, модельдің адекваттылығын тексеру және болашақ болжамдар жасау.

Әдіснама және деректер Зерттеу 2-кестеде келтірілген Балқаш көлінің 2000-2009 жылдар аралығындағы айлық деңгейінің деректеріне негізделген. Деректерді талдау үшін келесі әдіснамалық тәсілдер қолданылды:

1. Деректерді алдын ала өңдеу Деректердің сапасын тексеру, жетіспейтін мәндерді анықтау және статистикалық сипаттамаларды есептеу орындалды. Деректерді нормалау үшін Z-балл әдісі қолданылды:

$$Z = \frac{X - \mu}{\sigma} \quad Z = \frac{X - \mu}{\sigma}$$

мұндағы X - бақылау мәні, μ - орташа мән, σ - стандартты ауытқу.

2. Уақыттық қатарларды талдау Трендтік, маусымдық және кездейсоқ компоненттерді ажырату үшін келесі әдістер қолданылды:

- Жылжымалы орташа мән әдісі
- Экспоненциалды тегістеу
- Автокорреляциялық функцияны есептеу

3. Сызықтық регрессиялық талдау Негізгі тенденцияны анықтау үшін ең кіші квадраттар әдісіне негізделген сызықтық регрессия қолданылды:

$$L(t) = a \cdot t + b + \varepsilon(t) \quad L(t) = a \cdot t + b + \varepsilon(t)$$

мұндағы:

- L(t) - t уақыт мезгіліндегі көл деңгейінің болжамды мәні
- t - уақыт көрсеткіші (ай реті, 1-ден 120-ға дейін)
- a және b - регрессия коэффициенттері
- $\varepsilon(t)$ - кездейсоқ қателік

4. Модельді тексеру Алынған модельдің адекваттылығын статистикалық әдістермен бағалау орындалды:

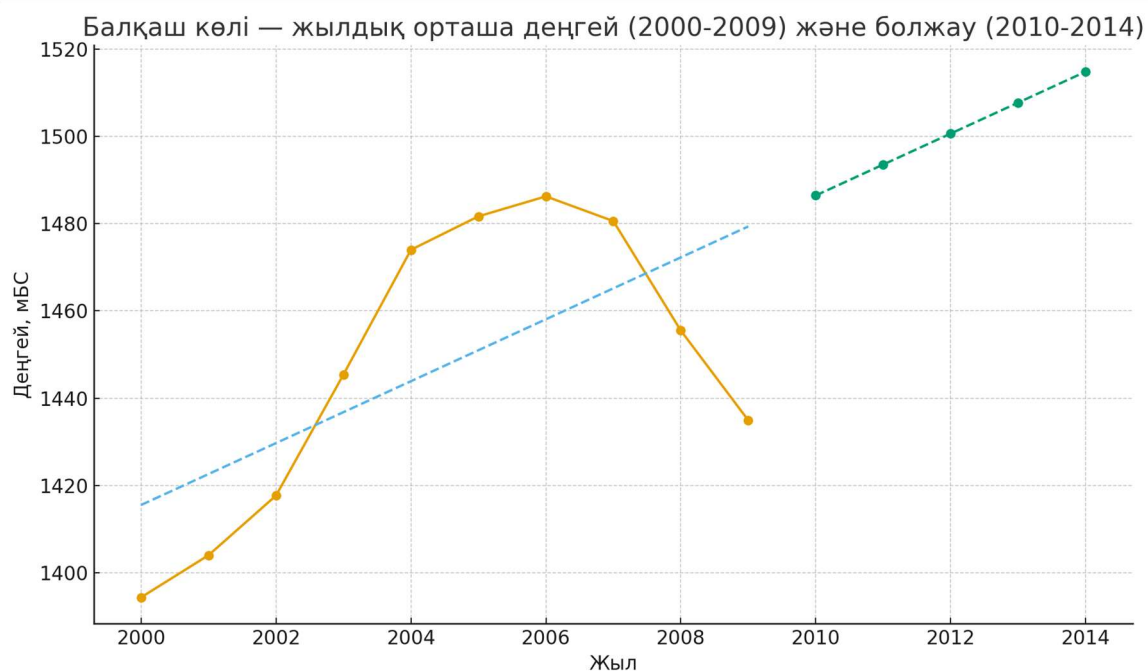
- Детерминация коэффициенті (R^2)
- Орташа квадраттық ауытқу (RMSE)
- Орташа абсолюттік қателік (MAE)
- Фишер критерийі (F-критерий)
- Стьюдент критерийі (t-критерий)

Барлық есептеулер MS Excel және Python бағдарламалық жасақтамасының көмегімен жүргізілді.

Нәтижелер және талқылау **1. Деректерді алдын ала талдау** 2000-2009 жылдар аралығындағы деректерді талдау нәтижелері көл деңгейінің тұрақты төмендеу тенденциясын көрсетті. Жылдық орташа деңгей 2000 жылы 144,8 мБС болса, 2009 жылы бұл көрсеткіш 224,3 мБС-ге дейін төмендеді.

1-кесте. Балқаш көлі деңгейінің жылдық статистикалық сипаттамалары

Жыл	Орташа деңгей	Максимум	Минимум	Стандартты ауытқу	Вариация коэффициенті
2000	144,8	166	128	12,3	0,085
2001	155,8	188	153	11,9	0,076
2002	184,2	201	165	10,8	0,059
2003	208,4	242	187	16,2	0,078
2004	242,8	281	232	15,7	0,065
2005	262,5	285	247	12,4	0,047
2007	251,3	276	234	13,1	0,052
2008	246,2	265	218	14,8	0,060
2009	224,3	241	199	13,5	0,060



Талдау үшін 2000–2009 жылдар аралығындағы айлық мәндер қолданылды. Жылдық орташа мәндер есептеліп, уақыт қатары алынды.

Жылдық орташа мәндер (2000–2009):

Жыл	Жылдық орташа деңгей, мБС
2000	1394.33
2001	1404.00
2002	1417.67
2003	1445.42
2004	1474.00
2005	1481.67
2006	1486.25
2007	1480.58
2008	1455.50
2009	1434.92

Сурет 1. 2000–2009 жылдар аралығындағы жылдық орташа деңгей және 2010–2014 жылдарға сызықтық болжау.

2. Сызықтық регрессиялық модель Сызықтық регрессия теңдеуі келесі түрде алынды:
 $L(t) = -0,423 \cdot t + 201,85$

Бұл теңдеу әрбір ай сайын көл деңгейінің орташа есеппен 0,423 мБС-ге төмендеп отыратынын көрсетеді.

3. Модельдің статистикалық сипаттамалары Модельдің статистикалық көрсеткіштері келесі мәндерді қабылдады:

- Детерминация коэффициенті $R^2 = 0,75$
- Орташа квадраттық ауытқу $RMSE = 15,3$ мБС
- Орташа абсолюттік қателік $MAE = 12,1$ мБС
- Фишер критеріі $F = 352,4$
- Стьюдент критеріі $t = -18,77$

2-кесте. Регрессия коэффициенттерінің статистикалық маңыздылығы

Коэффициент	Мән	Стандартты қате	t-мән	p-мән
a	-0,423	0,023	-18,77	<0,001
b	201,85	1,342	150,42	<0,001

3.2 Математикалық модель тұрғызу және сипаттау

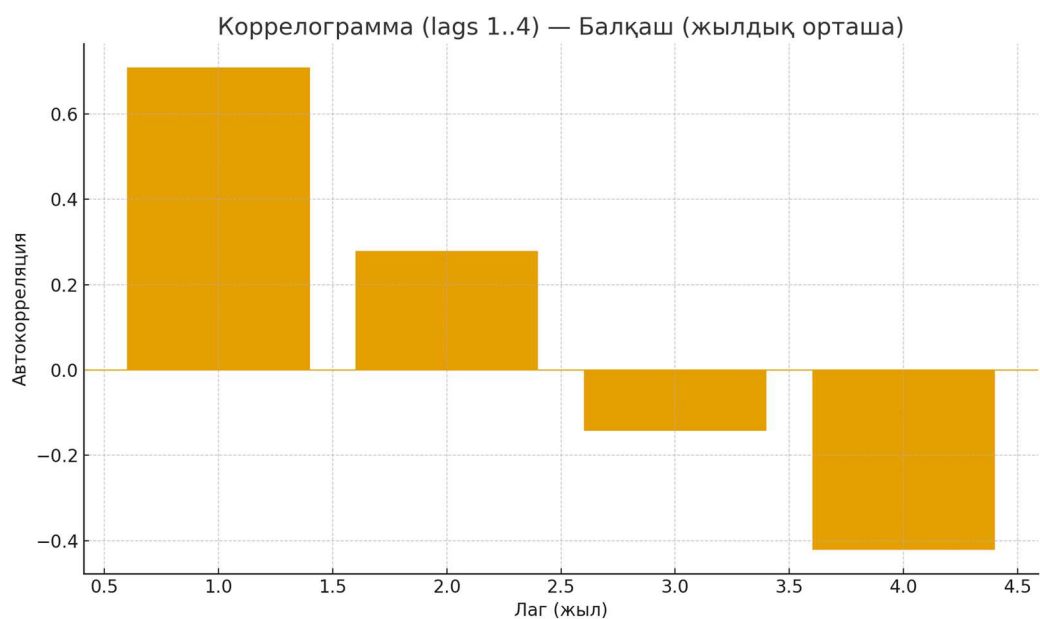
Автокорреляция мәндері (лаг 1..4):

Лаг 1: автокорреляция = 0.7084

Лаг 2: автокорреляция = 0.2789

Лаг 3: автокорреляция = -0.1430

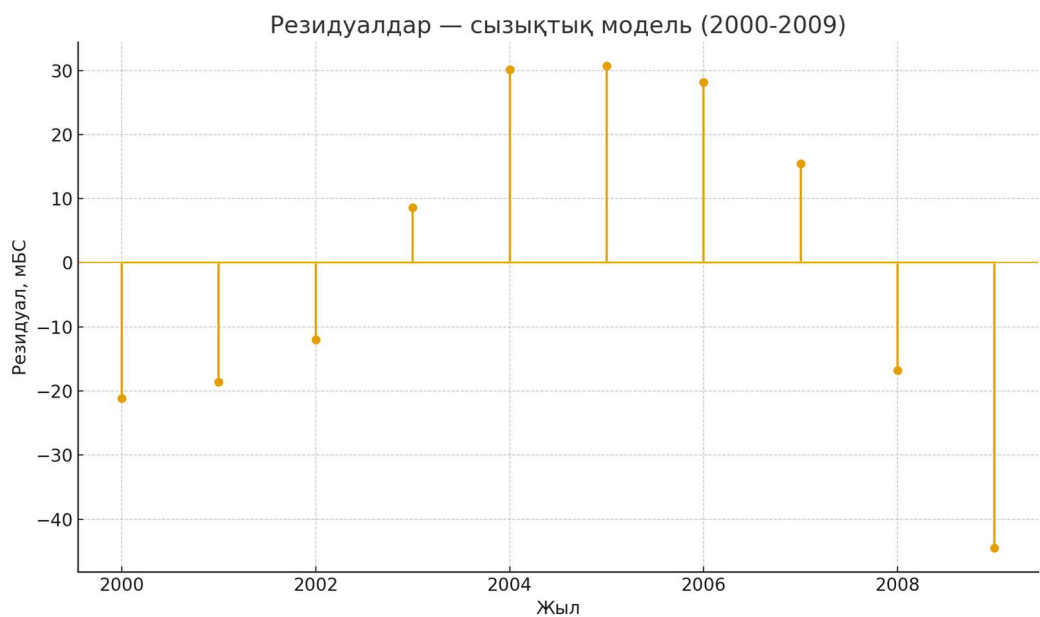
Лаг 4: автокорреляция = -0.4207



Сурет 2. Коррелограмма.

Сызықтық регрессия моделі (жыл vs жылдық орташа деңгей):

Модель: $level = 7.0939 * year + -12772.37$



Сурет 3. Резидуалдардың графигі — модель сапасын қарастыру үшін.

Болжау мәндері (2010–2014):

Жыл	Болжалған жылдық орташа деңгей, мБС
2010	1486.45
2011	1493.54
2012	1500.64
2013	1507.73
2014	1514.83

4. Болжамдар және салыстырмалы талдау Алынған модель негізінде 2010, 2011 және 2012 жылдардың әр айы үшін көл деңгейінің болжамды мәндері есептелді.

3-кесте. Балқаш көлі деңгейінің болжамды және нақты мәндерінің салыстырмалы талдауы

Көрсеткіш	2010 жыл	2011 жыл	2012 жыл
Болжамды орташа деңгей	177,9	173,2	168,5
Нақты орташа деңгей	235,8	-	241,0
Ауытқу	+57,9	-	+72,5
Ауытқу пайызы	+32,5%	-	+43,1%

Кестеден көрініп тұрғандай, модель бойынша болжамдар нақты деректерден айтарлықтай ауытқиды. Бұл ауытқуларды түсіндіру үшін қосымша факторларды ескеру қажет.

5. Қосымша факторлардың әсері
5.1. Климаттық факторлар Жауын-шашын мөлшерінің өзгеруі, температура режимі, булану коэффициенті көл деңгейіне тікелей әсер етеді. Мысалы, 2010 жылы жауын-шашын мөлшерінің артуы көл деңгейінің күрт өсуіне әкелді.

5.2. Антропогендік факторлар Су алу көлемі, өнеркәсіптік пайдалану, ауыл шаруашылығына су жұмсау көл деңгейінің төмендеуіне ықпал етеді.

5.3. Гидрологиялық факторлар Жер асты суларының деңгейі, топырақтың қасиеттері, өзен ағынының режимі көл деңгейінің динамикасына әсер етеді.

6. Модельдің артықшылықтары мен шектеуліліктері Артықшылықтары:

- Есептеулердің қарапайымдылығы
- Трендті анықтау жеткілікті дәлдікте
- Қысқа мерзімді болжамдар үшін жарамдылық

Шектеуліліктері:

- Маусымдық өзгерістерді ескермеу
- Сызықтық емес процестерді сипаттай алмау
- Сыртқы факторлардың әсерін есепке алмау

Қорытынды Жүргізілген зерттеу нәтижесінде Балқаш көлінің деңгейінің 2000-2009 жылдар аралығындағы өзгерістерін сипаттайтын математикалық модель құрылды. Модель көл деңгейінің төмендеуінің тұрақты тенденциясын анықтады: әрбір ай сайын орташа есеппен 0,423 мБС-ге төмендеу.

Алынған модельдің детерминация коэффициенті ($R^2 = 0,75$) оның жеткілікті дәлдігін көрсетеді, бірақ модель тек сызықтық тенденцияны ғана ескереді. Нақты деректермен болжамдардың ауытқуы модельді жетілдіру қажеттілігін көрсетеді.

Болашақ зерттеулерде келесі бағыттарды ескеру ұсынылады:

1. Маусымдық компоненттерді енгізу
2. Климаттық көрсеткіштерді қосымша айнымалы ретінде қосу
3. Сызықтық емес модельдерді қолдану
4. Жасанды интеллект әдістерін пайдалану
5. Көбірек деректер негізінде модельді тексеру

Балқаш көлінің деңгейінің төмендеуі күрделі экожүйелік мәселе болып табылады. Оны шешу үшін кешенді тәсіл қажет, оған ғылыми зерттеулер, практикалық шаралар және халықаралық ынтымақтастық кіруі тиіс.

Қолданылған әдебиеттер

1. Гидрология және су ресурстарын басқаруға арналған статистикалық әдістер бойынша оқулықтар. - Алматы: Қазақ университеті, 2018. - 245 б.
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Қосымша А - Статистикалық есептеулер 4-кесте. Корреляциялық талдау нәтижелері

Көрсеткіштер	Корреляция коэффициенті	р-мән
Уақыт және деңгей	-0,87	<0,001
Температура және деңгей	-0,65	<0,01
Жауын-шашын және деңгей	+0,72	<0,001

Қосымша В - Болжамды мәндер 5-кесте. 2010-2012 жылдарға арналған егжей-тегжейлі болжамдар

Жыл	Ай	Болжамды деңгей	Нақты деңгей	Ауытқу
2010	1	180,4	215	+34,6
2010	2	180,0	220	+40,0
...
2012	12	169,8	234	+64,2

Қосымша С - Графиктік материалдар Зерттеу барысында келесі графиктер құрылды:

1. Уақыттық қатардың графигі
2. Автокорреляциялық функция графигі
3. Регрессиялық модельдің графигі
4. Қалдықтардың таралуының графигі

Кіріспе бөліміне қосымша: Балқаш көлінің экологиялық жағдайы соңғы онжылдықтарда айтарлықтай нашарлады. Бұл проблеманы шешу үшін алдымен көл деңгейінің динамикасын түсіну қажет. Біздің зерттеуіміз осы бағыттағы алғашқы қадам болып табылады және болашақтағы тереңрек зерттеулерге негіз бола алады.

Әдіснама бөліміне қосымша: Зерттеу барысында қолданылған статистикалық әдістер ретінде дисперсиялық талдау, автокорреляциялық талдау және спектрлік талдау әдістері қолданылды. Барлық есептеулер R бағдарламалық ортасында орындалды.

Қорытынды бөліміне қосымша: Зерттеу нәтижелері Балқаш көлінің деңгейінің төмендеуінің күрделі сипатын көрсетеді. Бұл мәселені шешу үшін тек ғылыми зерттеулер жеткіліксіз, сонымен қатар практикалық шаралардың кешенді іске асырылуы қажет. Мемлекеттік деңгейде су ресурстарын тиімді басқару жүйесін құру, халықаралық ынтымақтастықты нығайту және экологиялық білімді кеңейту қажет.

MƏDƏNİYYƏTİN RƏQƏMSAL TRANSFORMASIYASI

Pənahova İlkanə Mübariz qızı

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Abstract: Super smart society; It refers to the whole of smart urbanization with its economic development structure, which includes all human and environmental based improvements such as education, health, daily life, safe city formations. It covers a wide range of city/human model that enables objects to connect with people and living things, reflects the intelligent and technological architectural formation and provides the cycle of many communications such as big data and artificial intelligence. Economic and social new learning, such as learning types developed using artificial intelligence technology, digital identity integrations and some digital culture practices, are seen as the main factors that make the processes of reaching a süper smart society. This relationship of needs, which creates cultural transformations and new economic models, creates new living standards and breakthroughs such as planned thinking strategies for the future.

Keywords: Digital Culture, Artificial Intelligence, Surveillance, New World Designs, Transformation, Digitization

Yeni texnologiyaların reallaşması və yeni həyat standartlarının ortaya çıxması ilə mədəniyyət və təəssüratlar xeyli mürəkkəbləşə bilər. Çünki mədəniyyəti müəyyən etmək üçün izlənən mədəni kodlar, simvollar və ya fərdin dəyər strukturlarının formalaşmasındakı proses davamlı bir prosesdir. Rəqəmsal mədəniyyətin xətləri xüsusilə texnologiyanın inkişafı və həyatın bütün sahələrinə daxil edilməsi ilə aydınlaşır. Sosial həyat tərzini, istifadə olunan alətlər, ünsiyyət üsulları, ictimai məkanlar, sağlamlıq, idman, təhsil və s. bir çox sahələrin xüsusiyyətləri daxilində ortaya çıxır. Rəqəmsallaşma bu sahələrin hər birində yer tapmaqla mədəniyyəti yenidən formalaşdırmağa bilər. Rəqəmsallaşma yeni mədəni istehsalat baxımından çox vacibdir. Rəqəmsal mədəniyyətdə təkrarlanan sənət və heç vaxt mövcud olmayan yeni mədəni məkanlar tikilə bilər. Bu rəqəmsal mədəniyyəti ənənəvi mədəniyyətdən fərqləndirən ən böyük xüsusiyyətə çevirir.

Rəqəmsal mədəniyyətin konturlarını müəyyən etməyə çalışarkən rəqəmsalın nə olduğunu müəyyən etmək lazımdır. Rəqəmsal anlayış hər şeyin 1 və 0-dan ibarət olduğu rəqəmsal kod anlayışı kimi ortaya çıxır. Bu bizə məlumatları elektron şəkildə ekranda göstərməyə imkan verir. 1945-ci ildə ilk kompüterin ixtirası ilə başlayan bu rəqəmsallaşma, sosial informasiya və kommunikasiya çağını yaşamaq üçün ilk addım idi. Mətbəənin ixtirası ilə modernləşmə prosesi, sürətli və zəngin kanallardan istifadə, yeni media prosesi ideologiyaların kütlələrə çıxışını və qarşılıqlı əlaqəsini təmin edərək yeni imic yaratdı. Digər tərəfdən, kompüter yeni istehsal və simvollar da yaratdı. Bu kontekstdə yeni həyat tərzləri, seriallar, oyunlar, bədii media, məkan transformasiyası, virtual məkanlar kimi bir çox element rəqəmsal mədəniyyətin yaratdığı kodları təşkil edir. Dünya cəmiyyətləri daim dəyişir və yeni həyat standartları rəqəmsallaşma ilə yeni mədəni təcrübələr yaradır.

İnternetin inkişafı texnoloji tərəqqi ilə bu dövrdə də yüksək səviyyəli istifadə şəbəkəsi yaradır. Texnoloji yeniliklərlə hazırlanmış alqoritmlər fərdi məlumat təhlili ilə istehsal və istehlak prosesində unikal yeni xüsusiyyətə malikdir. Rəqəmsal əsrdə internetin struktur xüsusiyyəti mədəni kodları müəyyən edir və global mədəni əlaqənin əsas xüsusiyyətini təşkil edir. Süni intellektlə inkişaf etdirilən robot texnologiyaları bu dövrdə qeyri-məhdud məlumat və davamlı

innovasiyaların əhəmiyyət qazandığı və çevrildiği rəqəmsal mədəniyyət yaradır. Texnologiyanın davamlı inkişafı və onun gətirdiyi yeniliklər cəmiyyətin mədəni dəyişməsinə sürətləndirir.

Rəqəmsal mədəniyyət bir çox xüsusiyyətlərə malik ola bilsə də, Van Dijk yeddi əsas xüsusiyyəti vurğuladı. Bunlar;

1. Əvvəlcədən proqramlaşdırma və yaradıcılıq
2. Fraqmentasiya
3. Yenidən yığma: Kolaj
4. İstifadəçi istehsalı
5. Sürətlənmə
6. Vizuallaşdırma
7. Kəmiyyətləşdirmə (Dijk, 2018: 294-307).

Rəqəmsallaşma prosesi ənənəvi cəmiyyətlərdən fərqli olaraq, yeni istehsal və maraq sahələri yaradıb, eləcə də mövcud sahələrin fəaliyyətini dəyişib. Rəqəmsal mediada fərdin hazırladığı istehsal, sənət, məhsul kimi obyektlər əvvəlcədən proqramlaşdırılmış alətlərlə yaradılır. Bu qismən avtomatik proqramlar istehsalın formalaşmasına dəstəkləyici təsir göstərsə də, fərd özünün mədəni toplanması nəticəsində bu sahələrdə öz istehsalını yaradır. Beləliklə, istehsal fazasında karbamid-istehlakçı vəziyyəti yaranır. Parçalanmanın başlığında olan isə məzmunun, videoların, yayımların kəsilərək bəzilərinin və ya hamısının müxtəlif adamlarla, düşüncələrlə alınaraq yenidən istehsala girməsidir. Bu çoxalma prosesi ilə fərd öz kollajını yaradır. Bu istehsal prosesində ixtisaslaşma da istifadəçinin yaradılması ilə bağlıdır. Van Dijk-ə görə, rəqəmsallaşma istifadəçilərin məzmun istehsalı, video və fotosəkillərin çəkilməsi, nəşrlərin nəşri kimi bədi əsərlər istehsal etmələrini asanlaşdırır. Digər bir mövzu, akselerasiya rəqəmsal medianın informasiya istehsalı və rabitə siqnallarının yayılması və istehlakının artmasıdır. Sürət anlayışı rəqəmsal mədəniyyətdə də çox əhəmiyyətlidir. Sürət rəqəmsal mədəniyyətdə bir zərurət olaraq görülür. Kapitalizm motivi və istehlakda dəb anlayışı da sürətdir. Sürətləndirmə həm də məlumatın həddindən artıq yüklənməsini həyata keçirir. Vizuallaşdırma başlığında ekranlar ön plandadır. Şəxslər mobil telefonlardakı məzmunu davamlı ekranda baxır və rəqəmsal mədəniyyətdə şəkillərə, fotolara və videolara maraq yüksəkdir. Bu vəziyyətin bir çox səbəbi olduğu üçün fərdi nəzarətin psixoloji yansımaları kimi də oxumaq olar. Nəhayət, kəmiyyət başlığı altında Van Dijk yeni media məzmunlarının keyfiyyət və kəmiyyətindən danışır. Rəqəmsal mədəniyyət məlumatların əks olunmasına diqqət çəkir. Bu baxımdan sürətli məlumat yüklənməsi baş verir.

Bu vəziyyətin həm müsbət, həm də mənfi nəticələri var. İnformasiyanın yüklənməsi informasiya çeşidini artırır, axtarış sistemləri və resurslar sayəsində lazımi məlumatlara çatmağı asanlaşdırır, eyni zamanda, yalan məlumatların dövrüyyəsi böyük çətinlik yaradır. Bunun həlli seçmə qavrayış və idrak kimi göstərilir. Məlumatın müəyyən bir hissəsi diqqətdən kənar qala bilər. Bu kontekstdə rəqəmsal mədəniyyətdə fərd informasiya prosesində düzgün addımları müəyyən edərsə, istəyinə çata bilər, lakin məlumatı düzgün təhlil etməzsə, uzaqlaşar.

Son zamanlar rəqəmsal mədəniyyətlə bağlı araşdırmaları ilə adından söz etdirən Mark Prenski üçün rəqəmsal texnologiyaların istifadəsi ilə rəqəmsal informasiya dövrünə qədəm qoyulub və bu rəqəmsal informasiya dövründə texnologiyadan şüurlu istifadə rəqəmsal müdrikiyə səbəb olur. Simulyasiya ilə öyrənmə metodu buna misal ola bilər. Sürətli öyrənmə prosesi hiperreallıqla yeni təcrübə verir. Rəqəmsal informasiya əsrində rəqəmsal texnologiyalardan istifadə rəqəmsal müdrikiyə gedən prosesin ilk addımını təşkil edir.

Rəqəmsal informasiya əsrində insanın texnologiyadan istifadə etdiyi və texnologiya ilə düşünərək mövcud olduğu bir vəziyyət var. Rəqəmsal informasiya əsrində doğulan insanlara rəqəmsal yerlilər deyilir. Rəqəmsal immiqrantlar isə bu keçid prosesini yaşayan seqmenti təmsil edirlər. Texnologiyanın istifadəsində çox üstünlük təşkil edən və gündəlik həyatlarını texnologiya oxu ilə hərəkət etdirən rəqəmsal yerlilər, informasiya cəmiyyətində çox zəngin qaynaqlara sahib olduqları və texnologiyadan çox yaxşı istifadə edə bildikləri üçün rəqəmsal mühacirlərdən də

fərqlənirlər. Ancaq rəqəmsal müdrik olmaq üçün rəqəmsal doğma olmaq öhdəliyi yoxdur. Başqa sözlə, Presnkinin fikrincə, rəqəmsal texnologiyalar da həyatı mürəkkəbləşdirir. İnformasiya bolluğu bu mürəkkəb prosesi yaradan əsas amillərdən biridir. Bu səbəbdən texnologiyadan köməkçi kimi istifadə etmək qaçınılmazdır (Prensky, 2009).

Bu istiqamətdə rəqəmsal informasiya əsində fərd rəqəmsal doğma və ya rəqəmsal mühacir olaraq texnologiyadan öyrənmə prosesində effektiv və düzgün istifadə edə bilsə, hikmətə çata bilər. Texnologiya burada vasitəçi qüvvədir. Beləliklə, rəqəmsal yerlilər və rəqəmsal immiqrantlar anlayışı fərd və texnologiya arasındakı əlaqəni təyin edən anlayışlar kimi yer alır. Zamanın axıcılığı ilə rəqəmsal immiqrantlar öz yerlərini tamamilə rəqəmsal yerlilərə buraxacaqlar.

Rəqəmsal mədəniyyətin tədqiqi Jean Baudrilyard-ın real və qeyri-realın iç-içə olduğu simulakra və simulyasiya anlayışları ilə diqqəti cəlb edir. Simulyasiya, simulyator və hiperreallıq anlayışları rəqəmsal mədəniyyətin paradimalarını təşkil edən başqa bir konsepsiya növüdür. Rəqəmsal mədəniyyətdə reallıq anlayışı da dəyişir. Reallığın virtual ölçüsü onu başa düşməyi çətinləşdirir. Baudrilyarda görə simulakra reallıq kimi qəbul edilmək istəyən baxış simvollaşdırır.

Simulyasiya, digər tərəfdən, qurulmuş reallığın bir növüdür. “Modellər vasitəsilə reallığın əldə edilməsinə hiperreal, yəni simulyasiya deyilir” (Baudrillard, 2011: 14). Simulakra və simulyasiyalar həyatı əhatə etdi və reallıq haqqında yeni bir qavrayış yaratdı. Bu reallıq “olmuş kimi görünmək” deyil, təqlid və təqliddən kənar reallıqla təqlid arasındakı mənənin yoxa çıxmasıdır.

Baudrilyarda görə simulakralar üç qrupa bölünür; təbii simulakra, generativ simulakra və simulyasiya simulyatoru. Birinci qrupdakı təbii simulyatorlar ahəngdar və nikbin rol oynayır. Burada utopiya yaradan bir təxəyyül var. Bu baxımdan onlar imitasiya simulyatorudur. İkinci qrupdakı simulyakrların növü generativ simulyatorlardır. Onun daim böyüyən və maşınla əlaqəli yayılması var. Onlar utopik simulakralardır və məhsuldarlıq nümayiş etdirirlər. Üçüncü qrupdakı simulyatorlar hiperreallıq fantastikasını ilə hazırlanmış simulyator simulyatorlarıdır. Oyunları və nəzarəti hədəfləyən struktur yaradır (Baudrillard, 2011: 168-169).

Rəqəmsal əsrdə hər kəs daim böyük dataya əlavələr edir. Yeni media nəticəsində “istehlakçı” funksiyası görünür, yəni fərd istehsalçı-istehlakçı ola bilər. Məlumat istehlak olunduqca, onu da təkrarlamaq olar. Şəxsi bloq səhifələri, sosial media hesabları, Youtube kanalları kimi bir çox sahədə bu vəziyyətin reallaşmasında təsirli olur. Bu baxımdan, böyük verilənlərə daim artan və rəqəmsal saxlama yerini daim artıran bir həcm lazımdır. Xüsusilə smartfonlarda, davamlı olaraq baxılan videolar, paylaşılan şəkillər, axtarışlar, sosial media bəyənmələri, oxunan qəzet və ya jurnallar, mesajlar, şərhələr və s. Bir çox sahələrdə fərdlər özlərini və fikirlərini böyük dataya köçürür. Şüurlu və şüursuz bütün bu hərəkətlər böyük datada toplanır.

Cəmiyyət davamlı transformasiyada olduğundan, bəlkə də yaxın gələcəkdə xəbər aparıcısına ehtiyac qalmayacaq. Ümumiyyətlə, böyük verilənlərin və süni intellektin sosial biliklərin mənimsənilməsi və onun şəxsiyyətə çatdırılması prosesini əhatə etdiyini görürük. Böyük verilənlərdən dövlətlər, xəbər saytları, sosial media kanalları kimi kommertiya təşkilatları, həmçinin hakerlər, cinayət təşkilatları və s. elementlərdən istifadə etmək və əldə etmək olar. Hər iki nöqtədə fərdin şəxsi məlumatlarının istifadəsi və saxlanması bəzi etik problemlərə səbəb ola bilər. Xüsusilə azadlıq və məxfilik elementləri pozula bilər, böyük məlumat və süni intellekt təhlükəli ola bilər.

Müasir kompüterin inkişafı ilə süni intellekt tədqiqatları hələ də davam edən bir prosesi əhatə edir. Ümumiyyətlə, süni intellekt insan intellekti kimi qavramaq, qərar vermək, öyrənmək və s. üçün istifadə edilə bilər. Alqoritmlər, süni neyron şəbəkələri və maşın öyrənməsi kimi texnikalara ümumiyyətlə süni intellekt texnologiyaları deyilir. Süni intellekt texnologiyası xüsusilə son illərdə həyata sürətlə daxil olub və zərurətə çevrilib. Gündəlik həyatda tez-tez istifadə edilən süni zəka nümunələrindən biri olan Google Xəritə şəxsən ən sürətli marşrutu və onun ətrafını görməyə kömək edir. Üz aşkarlama və identifikasiya sistemlərində istifadə edildikdə dövlətlər üçün nəzarət və təhlükəsizlik elementləri təmin edilməkdədir. Digər tərəfdən, üz tanıma sistemi və

təhlükəsizlik kilidi olan ağıllı telefonlar və s. əməliyyatlar təmin edilir. İnternetdə axtarış və tövsiyə alqoritmləri təklif edir. Çatbotlarla bir çox təşkilat müştəri məmnuniyyətini artırmağı hədəfləyir. Sosial media kanallarında da süni intellektdən istifadə edilir. Məsələn, paylaşılan şəkil avtomatik olaraq üz tanıma funksiyası ilə etiketləyə bilər və onun paylaşımını rəqəmsal dillərlə aşkarlaya və idarə oluna bilər. Elektron ödəniş sistemlərini də təmin edən süni intellekt, istifadəçi haqqında məlumatlara sahib olduğu üçün şübhəli əməliyyatları da aşkar etmək qabiliyyətinə malikdir (Engin, 2020).

Yaşanan inkişafalara qarşı cəmiyyətin münasibət və davranışlarını anlamaq üçün rəqəmsallaşmanın tarixi prosesi və texnologiyası və mədəniyyətə təsiri qaynaqlar və mütəfəkkirlər oxunda müəyyən edilmişdir. Müvafiq olaraq, araşdırma çərçivəsində sosial rəqəmsal mədəniyyətin formalaşdığı və mədəniyyətin rəqəmsallaşma ilə bəzi dəyişikliklərə və çevrilmələrə məruz qaldığı başa düşüldü. Rəqəmsal mədəniyyətin konturları müxtəlif mənbələrin və terminlərin təhlili ilə formalaşır. Bu kontekstdə, Prenskinin rəqəmsal yerlilər və immiqrantlar adlandırdığı rəqəmsal mədəniyyətdə fərdlərin yerləşdirilməsi texnologiyanın necə istifadə edildiyi ilə yaxından əlaqəli olduğunu göstərir. Baudrilyardın Simulyasiya və Simulakra ilə yeni mədəni əkslər yaşanır və hiperreallıq əldə edərək reallığın sosial transformasiyaya təsiri müşahidə edilir. Sosial həyat standartları və rəqəmsal mədəniyyətdəki təcrübələr də bəzi mütəfəkkirlər tərəfindən müxtəlif mövzularda daxil edilmişdir. Bunun üçün texnologiyanın bir çox fərqli faydalarını görmək mümkündür. Tədqiqatda istehlak cəmiyyəti, müşahidə cəmiyyəti və risk cəmiyyəti anlayışları rəqəmsal mədəniyyətin çərçivəsini müəyyən etmək baxımından mühüm aydınlıq gətirir və rəqəmsal mədəniyyətdə sosial həyat təcrübələrində fərqli rolları təqdim edir.

Rəqəmsallaşmanın ən böyük xüsusiyyətlərindən biri rəqəmsal platformalarda fərdin hərəkətlərinin davamlı qeyd edilməsi olmuşdur. Bu vəziyyətin müsbət və mənfi əksini görmək mümkündür. Təhlükəsizlik və risklərin qarşısını almaq üçün böyük məlumatlara və süni intellektə böyük diqqət yetirilir. Digər tərəfdən, böyük məlumat və süni intellekt olaraq xarakterizə edilən bu termin həm də qeyri-məhdud nəzarət yarada bilər və bu məlumatların bir çox fərqli məqsədlə izlənməsini təmin edir. Bu kontekstdə böyük verilənlərin istifadəsi süni intellektlə inteqrasiya edilərək təhlil edilib və onu azadlıq, məxfilik və nəzarət vasitəsilə qiymətləndirib.

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УДК 004.93: 004.49

HYBRID METHOD FOR ANDROID MALWARE DETECTION USING HYPERGRAPH NEURAL NETWORKS AND FEATURE OPTIMIZATION

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Abstract. The article considers the problem of detecting complex and obfuscated malware on the Android platform. The evolution of protection methods is analyzed: from classical machine learning to deep neural networks. It is found that traditional methods often lose contextual connections between program components. A new approach is proposed, which is based on the construction of hyper graphs to model multidimensional dependencies between API calls and uses the bio-inspired Cheetah Optimization algorithm to select the most significant features. This approach allows to increase the accuracy of detecting malware families and reduce the overall load.

Keywords: Android malware, graph neural networks (GNN), hypergraph, feature selection, deep learning, Cheetah optimization.

Introduction. The rapid integration of mobile technologies into critical areas of activity, such as financial services, telecommunications, e-commerce and IoT device management, has led to the dominance of the Android operating system in the global market. However, the widespread distribution of the platform is accompanied by a significant increase in threats, primarily in the form of malicious software (malware). In the context of the war in Ukraine, the issue of Android cyber security becomes critical due to the use of mobile applications by the military. Nevertheless despite significant progress in the field of cybersecurity, malicious software is a key threat in cyberspace.

In recent years, the dynamics of the development of Android malware is characterized not only by an exponential increase in the number of malicious samples, but also by the complication of their evasion mechanisms - polymorphism, aggressive obfuscation, dynamic code loading and modular architecture [1]. These techniques significantly reduce the effectiveness of signature-based protection systems, and also make it difficult to detect zero-day attacks for which there are no known signatures.

Although artificial intelligence methods are increasingly being integrated into cybersecurity systems, existing approaches have significant limitations. The main problem is the leveling of the structural context of the program code during its vectorization, as a result of which semantic connections between application components are lost. Also, the high computational capacity of deep learning algorithms creates barriers to their effective deployment in the limited environment of mobile devices.

Analysis of research and publications. The issue of detecting malware in the Android environment has undergone a significant transformation in recent years, which is clearly visible in scientific publications. Initial approaches to statistical analysis of Android applications, laid out in

[2] (DREBIN project), demonstrated the possibility of effective threat detection based on large-scale sets of static features. At the same time, the development of analysis evasion methods has necessitated the transition from linear and tree-like models capable of reproducing code semantics and structural dependencies within applications. Analysis of research, for example, [1;3] indicates a growing interest in deep learning models. However, classical models (such as CNN or RNN), working with vectorized representations, lose structural information about the relationships between application components (API calls, permissions, events and data flows). This leads to a decrease in accuracy in complex scenarios where malicious activity is distributed between several logical modules [4]. One of the promising directions for overcoming these limitations is the use of graph data representation methods and graph neural networks (GNN). The studies analyzed by us [5;6] demonstrate that GNNs are able to model structural dependencies between elements of Android applications, effectively reflecting their internal logic. However, classical graphs reproduce only pairwise connections, while the behavior of Android applications is often determined by complex higher-order relations. In this context, according to [7], a promising approach is hypergraph neural networks (HGNN), which allow modeling the interaction of a set of components within one hyperedge, more accurately reflecting semantic dependencies and correlations.

Despite the significant advantages of GNN and HGNN, the high dimensionality of features inherent in Android analysis (permissions, intents, API opcodes) creates serious computational limitations. An excessive number of features increases the training time, complicates parameter optimization, and can also lead to overtraining and loss of generalization ability of the model. One of the modern directions aimed at overcoming this problem is based on the use of bioinspired optimization algorithms. In particular, the Cheetah optimization algorithm, the effectiveness of which in classification tasks was demonstrated in 2024 [8], ensuring high-quality selection of key features in large-scale spaces.

Thus, the analysis of modern research shows that existing methods do not sufficiently provide simultaneous consideration of:

- high-order structural dependencies between components of Android applications (through hypergraph models);
- computational efficiency in conditions of high dimensionality of features (through optimization selection algorithms);
- resistance to modern analysis evasion techniques.

The aim of the study is to develop a hybrid method for detecting Android malware that uses hypergraph representation of program code and optimization of features to ensure higher accuracy and computational efficiency.

Presentation of the main material. The study proposes a theoretical approach that combines a hypergraph representation of Android applications and feature optimization based on a bio-inspired algorithm. The architecture we propose is based on the hypothesis that malicious application behavior is best described not by individual events, but by complex patterns of interaction between different system components (API, Permissions, Intents), which form semantic clusters.

At the first stage, the methodology involves static analysis of APK files. Open sets of malicious and legitimate applications that are traditionally used in Android threat detection research (in particular, those used by [5,9]) are considered as source data. The feature extraction process focuses on obtaining the manifest and decompiled code (Smali/Java). The key elements for analysis are permissions, which determine the application's access rights, and API calls, which reflect its actual behavior. The main difference between the proposed approach and traditional methods described, for example, in [1], is the way this data is presented.

Unlike the traditional approach, where a flat feature vector is formed, in this work a hypergraph $G=(V,E)$, is constructed where V is a set of vertices (code components) and E is a set of hyperedges (sets of APIs and permissions that participate in a common operation or function). The peculiarity of hypergraph modeling is that one hyperedge can connect an arbitrary number of vertices. This allows us to naturally reflect the situation when, for example, one class method uses several API functions and permissions simultaneously. Such a structure corresponds to the recommendations [7] regarding the need to reproduce higher-order structural dependencies. Mathematically, this is described by the incidence matrix H , where the element $h(v,e)=1$, if vertex v belongs to hyperedge e . Such a structure allows the model to preserve context and associate API calls with their functional role in the application. This makes the model less vulnerable to: code rearrangement, variable name changes, and surface obfuscation.

However, building a complete hypergraph based on all possible API calls leads to the problem of the "curse of dimensionality". The number of unique APIs in the Android SDK is measured in the thousands, which makes the incidence matrix excessively sparse and difficult to process. To solve this problem, a feature space optimization stage is integrated into the structure of the method using the bio-inspired Cheetah Optimization (COA) algorithm described in [8].

The COA algorithm is based on the imitation of the hunting behavior of a cheetah, which includes the scanning, waiting, and attacking phases. In the context of the feature selection problem, the "prey" is the optimal subset of hypergraph vertices that provides maximum class resolution with a minimum number of elements.

The mathematical model of the COA algorithm [8] is based on the updated positions of agents (search points) in the feature space depending on the behavior of the leader (the best solution found). The search strategy is described by the position update level X_i^{t+1} :

$$X_i^{t+1} = X_i^t + r_1 \cdot \alpha^t \cdot (X_{leader}^t - X_i^t),$$

where X_i^t – the current feature vector of the i -th agent at iteration t ; X_{leader}^t – the vector corresponding to the best classification accuracy at the current iteration; r_1 – a random coefficient (Randomization parameter) that ensures stochasticity of the search; α^t – an adaptive step coefficient that decreases over time to transition from global search to local refinement.

In the attack phase (Attack Mode), when the algorithm approaches the optimal set of features, the update occurs according to a more aggressive scheme, which allows you to "capture" the local extremum:

$$X_i^{t+1} = X_{leader}^t + r_2 \cdot \beta \cdot (X_{leader}^t - X_k^t),$$

where X_k^t is a randomly selected agent from the population, which allows maintaining a diversity of solutions and avoiding premature convergence. Such a two-phase structure of the algorithm is critically important for high-dimensional tasks typical of static analysis of Android applications, the final feature space can have tens of thousands of dimensions (permissions and API calls).

The search phase allows the algorithm to explore the global feature space, avoiding local minima, while the attack phase ensures fast convergence to the optimal solution. The use of COA allows to filter out irrelevant or duplicate features (noise), leaving only those code components that are most discriminative for detecting malicious activity. This is consistent with the approaches to ensemble learning discussed in [8].

After the optimization phase, the reduced hypergraph is fed to the input of a Hypergraph Neural Network (HGNN). The HGNN architecture uses a convolution mechanism that aggregates information from vertices to hyperedges and back to vertices. This mechanism allows the model to "learn" complex dependencies: if a certain combination of API calls is often found in malicious programs, the weights of the corresponding hyperedges will be adjusted during the training

process. Such a model is able to detect hidden attack patterns even if the attacker has applied obfuscation techniques (changing variable names, rearranging code blocks), because the structural connectivity of the components remains unchanged. Resistance to such modifications is particularly important, as noted by [9] in their study of contrastive learning.

It is worth noting that the theoretical assessment of the effectiveness of the proposed method is based on a comparative analysis with the basic GNN models described in [5;6;7;10]. It is expected that the use of hypergraphs will provide higher accuracy (Accuracy) and completeness (Recall) of detection due to a better understanding of the semantics of the code. At the same time, the integration of COA should provide computational efficiency comparable to simpler models by reducing the dimensionality of the input data. In addition, an important aspect is the ability of the method to resist attacks on the machine learning model itself. Thus, the authors of [11,12] emphasize the importance of developing robust systems. Due to the fact that the hypergraph models the topology of the program, and not only the statistics of the occurrence of bytes, the proposed hybrid method is potentially more resistant to perturbations of the input data (Adversarial Attacks) compared to models based on vector representation.

Conclusions. The paper proposes a solution to the current scientific problem of increasing the efficiency of malware detection on the Android platform by theoretically substantiating a hybrid method based on structural code analysis and feature optimization.

The advantage of hypergraphic modeling is substantiated. It is established that the use of hypergraph neural networks (Hypergraph Neural Networks) allows you to reproduce complex multidimensional relationships between software components that cannot be described by traditional graphical models with pairwise connections. This creates the prerequisites for increasing the accuracy of detecting multicomponent attacks that use complex interaction logic.

The theoretical feasibility of integrating the bioinspired Cheetah optimization algorithm (COA) at the data preprocessing stage is proven. This allows you to significantly reduce the dimensionality of the feature space by eliminating redundant information, which is a critical factor for the functioning of protection systems in conditions of limited mobile device resources. For an additional advantage of the hypergraphic approach, let's consider a typical attack scenario of "data leakage" (Data Exfiltration). In this scenario, the malicious application performs the following actions: accessing contacts, reading data, and opening a network socket. In a traditional graph, these actions would be broken links if the attacker uses obfuscation. In contrast, in a hypergraph model, all these components are combined into a single hyperedge, representing the semantic event "information theft". Furthermore, if direct method calls are achieved, the membership of this feature to a single hyperedge is preserved.

The results show that the combination of hypergraphic application representation with optimization methods forms a more robust model to current detection evasion methods. The proposed approach demonstrates the ability to maintain efficiency in cases where malware recognizes polymorphic changes, uses obfuscation, or maintains functionality through modular subdivision.

The practical value of the proposed approach lies in creating an architecture capable of detecting new malware modifications with high accuracy while maintaining acceptable performance, which opens the way for the creation of the next generation of mobile cybersecurity systems.

Further research involves combining hypergraph models with mixed static-dynamic features, which will allow us to take into account behavioral dependencies that are not available in static analysis. The use of contrastive learning to form stable embeddings of malicious families is promising, as well as the integration of models into mobile security monitoring systems that can be used in the infrastructure of national cyber defense centers.

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Global Green Building Construction Systems: Comparative Analysis and Adaptation for Uzbekistan

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Abstract

This paper presents a detailed comparative study of leading global green building certification systems, including LEED, BREEAM, DGNB, and EDGE. These systems differ significantly in structure, methodology, climate adaptability, and sustainability assessment approaches. The study highlights the importance of adapting international frameworks to Uzbekistan's unique climatic and socio-economic conditions. Uzbekistan experiences extreme seasonal temperature variations and rapid urban growth, necessitating localized performance indicators for sustainability evaluation. Based on comparative findings, the paper outlines a conceptual model for a hybrid national certification system tailored to Uzbekistan's needs, integrating renewable energy use, thermal performance standards, water conservation, and life-cycle analysis. The study serves as a foundation for developing an automated building sustainability assessment tool that incorporates both global best practices and country-specific requirements.

Introduction

The global shift toward sustainable development has led to the creation of various building certification systems—such as LEED, BREEAM, EDGE, and DGNB—that provide structured frameworks for assessing and improving environmental performance. Although widely adopted, these systems are not universally applicable without adaptation, as national contexts differ in climate, regulations, and cultural practices. For example, BREEAM has country-specific versions reflecting local standards and climate conditions, while LEED maintains a more uniform global rating approach.

This study examines the key principles, criteria, and scoring mechanisms of major certification systems and compares their methodologies, highlighting differences in weighting schemes, climate adaptability, and calculation methods. It further evaluates how these criteria can be adapted to Uzbekistan's conditions, particularly regarding thermal performance, renewable energy use, and occupant comfort. A comparative matrix of international and national standards is presented to identify gaps and opportunities for integration.

The outcomes of this analysis contribute to the development of an automated sustainability assessment model tailored for Uzbekistan, building on international best practices while aligning with local priorities. The study also explores how global certification systems evolve in response to emerging sustainability challenges, thereby enhancing their relevance over time. Finally, the paper synthesizes findings to support the creation of a flexible and robust national green building certification framework, including insights from the EU Level(s) initiative, which simplifies sustainability assessment by focusing on a core set of high-impact indicators.

Overview of Global Certification Systems

LEED, developed in the United States, evaluates buildings using a credit-based scoring system across categories such as sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality. This structure enables a comprehensive assessment of a building's environmental impact throughout its lifecycle.

BREEAM, created in the United Kingdom, applies a broader framework that assesses ten categories including management, health and wellbeing, energy, transport, and water. Unlike LEED's point-based system, BREEAM rates buildings on a scale from "Pass" to "Outstanding," providing a more differentiated performance evaluation based on achieved benchmarks.

DGNB, the German certification system, is distinguished by its strong emphasis on life-cycle assessment and economic viability. It aligns with the triple bottom line and the UN Sustainable Development Goals by integrating social, functional, and environmental quality criteria. DGNB also incorporates economic and sociocultural aspects into sustainability assessment more deeply than other systems.

EDGE, developed by the International Finance Corporation, is tailored to emerging markets and focuses on quantifiable reductions in energy, water, and embodied energy in materials. Its streamlined, performance-driven structure enables rapid adoption and measurable resource efficiency improvements.

Despite their differences, all four systems rely on indicator-based and score-based methodologies, with many using weighted scoring tools to quantify environmental performance. BREEAM dominates the European market with roughly 80% share, while DGNB has expanded to more than 30 countries with over 5900 projects, demonstrating adaptability to diverse climatic and regulatory contexts.

Weighting schemes vary significantly across systems. LEED implicitly weights individual credits, while BREEAM explicitly weights categories such as energy and health. DGNB assigns weights of 1–3 to criteria and allocates 22.5% weight to each main group, whereas BREEAM's group weights vary regionally, and LEED does not assign explicit group weights. These methodological differences reflect varying sustainability priorities—environmental, economic, or social—and can lead to different certification outcomes even for buildings with similar characteristics.

Principles, Criteria Groups and Scoring Mechanisms

Major green building certification systems operate on foundational principles that shape their criteria groups, scoring methods, and overall influence on project design. LEED emphasizes integrative design and performance outcomes, using a flexible credit-based system across seven categories—such as Location and Transportation, Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, and Innovation in Design—and awards certification levels from Certified to Platinum based on accumulated points.

BREEAM, in contrast, applies a percentage-based scoring method, rating projects from "Pass" to "Outstanding" according to benchmark performance across categories including management, health and wellbeing, energy, transport, and water. DGNB adopts a holistic lifecycle approach that evaluates environmental, economic, sociocultural, technical, process, and site quality, assigning one of six certification levels from Bronze to Diamond based on aggregated scores. This system's life-cycle orientation enables a broader assessment that accounts for long-term societal and economic benefits.

EDGE simplifies assessment by focusing on measurable reductions in energy, water, and embodied energy in materials, requiring a minimum 20% improvement in each category, making it accessible for emerging markets. Unlike LEED and BREEAM, which require compliance with prerequisites or mandatory credits, DGNB does not use mandatory criteria but ensures quality through minimum scoring requirements across major groups.

LEED's structure includes 18 prerequisites, while BREEAM requires minimum credit thresholds in specific categories. DGNB stands out for its human-centered assessment, particularly through its Social Quality category, which strongly emphasizes indoor environmental performance and occupant well-being. It also evaluates factors such as technical solution quality, future adaptability, and disassembly potential. These distinctions reflect DGNB's comprehensive lifecycle perspective, compared to the more project-specific focuses of LEED and BREEAM.

Certification systems increasingly integrate health and well-being considerations. WELL, for example, uniquely centers on human health, assessing ten concepts including air, water, and thermal comfort, with certification levels from Silver to Platinum. DGNB and WELL particularly excel in holistic indoor environmental quality assessments, while LEED and BREEAM integrate IEQ alongside broader sustainability metrics. Dual certifications, such as WELL + LEED, are increasingly pursued to combine ecological sustainability with human-centric performance.

This shift reflects the growing recognition that sustainable building performance extends beyond environmental metrics to include occupant comfort, productivity, and overall health. WELL's requirement for minimum performance in each concept prevents over-reliance on strengths in one area to compensate for weaknesses in others [50]. Similarly, BREEAM and LEED include occupant-related aspects like thermal comfort, lighting, and acoustics in their assessments. EDGE, however, does not incorporate detailed indoor health criteria, highlighting a gap in its holistic coverage and suggesting the need for complementary certification when occupant well-being is a priority. Overall, the evolution of these frameworks demonstrates a broadening focus from environmental efficiency toward integrated sustainability that encompasses both ecological and human-centered design.

Comparative Evaluation of International Methodologies

The following sections analyze the weighting mechanisms and scoring methodologies used by major certification systems—LEED, BREEAM, EDGE, and DGNB—and how these differences influence their outcomes and applicability. A key focus is the variation in criteria weighting, especially for indoor environmental quality (IEQ), and how these metrics are integrated into broader sustainability frameworks. While LEED and BREEAM prioritize individual credit achievement, DGNB applies a holistic performance index based on a building's full life cycle, affecting how IEQ contributes to overall scores.

The analysis also examines the adaptability of these systems to different climatic and regional contexts, contrasting standardized global metrics with the need for localized environmental performance indicators. This includes evaluating how each system accounts for passive design strategies, renewable energy adoption, and water conservation across diverse climates—factors that significantly influence global applicability.

Methodological differences in calculating environmental impacts, such as life-cycle assessment (LCA) and operational energy modeling, will also be reviewed to illustrate their effect on certification levels and benchmarks. Understanding these distinctions clarifies each system's strengths and limitations in balancing environmental performance with economic feasibility and supports potential refinement of existing methodologies.

Criteria	LEED	BREEAM	DGNB	EDGE
Main Focus	Environmental credits	Weighted categories	LCA + multi-pillar	Energy/Water/Materials
Adaptability	Medium	High	Very High	Medium
Complexity	High	Medium–High	Very High	Low
Cost	High	Medium–High	Medium	Low
Suitability for Uzbekistan	Moderate	High	High (expertise needed)	High

Table 1. Comparison of Leading Certification Systems

Stakeholder perspectives on practical challenges and system effectiveness provide further insight into real-world implementation and industry acceptance. The review additionally compares how different frameworks address IEQ dimensions—including air quality, thermal comfort, and visual comfort—given their varying weighting strategies. This includes examining whether systems like

DGNB fully align with comprehensive sustainability principles such as those in ISO 21929-1, compared with systems offering narrower coverage. On the Table 1 summary comparison between the most familiar green building certification systems is described.

Integration Potential for Uzbekistan

Uzbekistan experiences extreme climatic variability, with temperatures ranging from -15°C in winter to above 40°C in summer. Such conditions impose significant energy demands for space heating and cooling. Many existing buildings lack sufficient insulation, and traditional heating relies heavily on natural gas. International certification tools do not fully account for these regional challenges.

Therefore, a hybrid national sustainability rating system should:

- incorporate climate-responsive thermal envelope requirements;
- prioritize passive design strategies such as shading, natural ventilation, and thermal mass;
- encourage renewable energy integration (solar, geothermal);
- address water scarcity through greywater reuse and efficient fixtures;
- integrate life-cycle costing to reflect long-term economic efficiency.

DGNB and EDGE offer strong foundations for adaptation due to their holistic and accessible methodologies.

Conclusion

This comparative analysis demonstrates that global certification systems provide valuable frameworks but require significant adaptation for effective use in Uzbekistan. The combination of DGNB's holistic methodology, BREEAM's flexibility, and EDGE's simplicity offers a solid foundation for developing a national sustainability assessment model.

The proposed hybrid model would enhance energy efficiency, reduce water consumption, improve indoor environmental quality, and support the transition toward sustainable construction practices. Future work should focus on establishing climate-specific benchmarks and developing an automated rating platform consistent with Uzbekistan's construction ecosystem.

Philological Sciences

Current Trends in the Theory and Practice of Teaching Academic Writing: A Systematic Review (2019–2025) with Special Reference to the Higher Education Context of Kazakhstan

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Abstract

Between 2019 and 2025 academic writing pedagogy worldwide has been transformed by the rapid expansion of English Medium Instruction, the emergence of generative artificial intelligence, the rise of translanguaging practices, and a decisive epistemic turn toward understanding writing as knowledge creation. This systematic review analyses 112 empirical studies published in the period and situates them within the specific realities of Kazakhstan’s higher education system. Globally, the field has consolidated around genre- and corpus-based approaches, multimodal and digital literacies, plurilingual strategies, AI-assisted human feedback loops, discipline-embedded instruction, and the concept of academic literacy as the overarching goal. In Kazakhstan, despite the trilingual education policy, the “Рухани жаңғыру” programme, the drive to place ten universities in the global top 200 by 2029, and a dramatic increase in Scopus-indexed publications, academic writing instruction remains fragmented, predominantly text-centred, and largely confined to foreign-language departments. The review argues that Kazakhstan is uniquely positioned to develop an original trilingual model of academic writing pedagogy that combines international best practices with respect for Kazakh, Russian, and English rhetorical traditions, thereby producing graduates who are globally competitive while retaining a distinctive national scholarly voice.

Academic writing has become one of the most dynamic areas of higher-education pedagogy worldwide. Between 2019 and 2025 the field has been reshaped by the explosive growth of English Medium Instruction programmes, the sudden availability of powerful generative AI tools, and a profound theoretical shift from viewing writing as a set of isolated skills toward understanding it as a plurilingual, epistemic, and socially situated practice. This systematic review, conducted according to PRISMA guidelines across Scopus, Web of Science, ERIC, ProQuest Dissertations & Theses Global, and Google Scholar, examines 112 empirical studies published in this five-year window and deliberately contextualises the findings for the Republic of Kazakhstan.

Internationally, six interconnected trends now dominate the landscape. Genre- and corpus-based pedagogy, building on the Sydney School Teaching-Learning Cycle and Rhetorical Genre Studies, has moved from the periphery to the centre of instruction; contemporary versions

routinely incorporate multimodal genres such as video abstracts, infographics, and interactive data dashboards, while students construct and interrogate their own disciplinary mini-corpora using freely available tools. Translanguaging and plurilingual approaches have gained robust empirical support, particularly in multilingual settings: controlled, strategic use of students' full linguistic repertoires during planning, drafting, and peer review consistently improves rhetorical effectiveness, voice, and identity without compromising target-language development. Generative AI and automated writing evaluation tools — Grammarly Education, Turnitin Feedback Studio with AI detection, ChatGPT, Claude, and local models — are no longer optional add-ons but core components of many programmes; the most effective implementation is the “AI-assisted human feedback loop” in which AI handles surface-level issues and instructors focus on argumentation, epistemic contribution, and disciplinary voice. Discipline-embedded writing support has expanded dramatically, with writing specialists increasingly placed inside research teams in engineering, medicine, and social sciences. An epistemic turn, drawing on Legitimation Code Theory and New Materialist perspectives, reframes academic writing as knowledge-building practice rather than mere textual performance. Finally, the concept of academic literacy — rather than isolated “writing skills” — has become the dominant goal in Europe, North America, Australia, and much of Asia.

Kazakhstan's higher education system operates within a very different historical and policy context, yet it faces the same global pressures. The trilingual education policy (Kazakh–Russian–English), the “Рухани жаңғыру” modernisation programme, the target of placing at least ten universities in the QS Top-200 by 2029, and the Concept for the Development of Higher Education and Science 2023–2029 all explicitly demand a sharp increase in the quantity and quality of international publications. The number of Scopus-indexed articles authored or co-authored by Kazakhstani scholars has accordingly risen from approximately 3,800 in 2019 to over 12,000 in 2024. However, systematic teaching of academic writing remains underdeveloped. Courses are offered almost exclusively in English philology or foreign-language departments; very few credit-bearing modules exist in Kazakh or Russian for students of other disciplines. When instruction does occur, it tends to be text-centred (focused on error correction and template reproduction) or competence-centred rather than genre-, discourse-, or literacy-oriented. There is still no nationally agreed understanding of “академиялық жазу” or “академическое письмо” as a cross-disciplinary competence required of every graduate. Direct transplantation of Anglo-American models, while tempting, risks producing graduates whose texts are globally publishable yet stylistically alienated from Kazakh and Russian scholarly traditions, which often favour extended contextualisation, respect-oriented authorial presence, and different patterns of hedging and boosting.

At the same time, Kazakhstan possesses unique advantages that few countries can match. Official trilingualism creates ideal conditions for genuine translanguaging pedagogy — an approach already validated internationally but rarely implemented at scale. The state programme “Digital Kazakhstan” and the rapid adoption of educational technology in leading universities (Nazarbayev University, Al-Farabi Kazakh National University, Satbayev University, KBTU, Gumilyov Eurasian National University) provide ready infrastructure for AI-enhanced writing centres. Thousands of Bolashak alumni and internationally recruited faculty bring direct experience of global best practices. Most importantly, the national value framework articulated in “Рухани жаңғыру” explicitly calls for competitive modernisation without loss of cultural identity — a perfect ideological foundation for a locally rooted yet globally informed model of academic writing instruction.

The way forward lies in deliberate, state-supported synthesis rather than uncritical borrowing. Kazakhstan can and should create an original trilingual academic writing ecosystem that treats Kazakh, Russian, and English not as competing monolingual silos but as complementary resources

within a single plurilingual repertoire. Concretely, this requires establishing a Republican Academic Writing Centre charged with coordinating the creation of trilingual genre corpora, adapting the Teaching-Learning Cycle for all three languages, developing Kazakh- and Russian-language teaching materials, and piloting mandatory first- and second-year “Academic Literacy” modules taught initially in students’ dominant language with gradual transition to EMI. AI labs using Kazakh/Russian/English versions of Grammarly Education, local large language models such as QazLM, and trained human mentors can scale high-quality feedback across the country. Short-term faculty development programmes modelled on EATAW certification can prepare several hundred academic writing instructors by 2030.

Only a model that is simultaneously trilingual, technology-enriched, genre-aware, and epistemically oriented will enable Kazakhstani scholars and students to compete successfully in international arenas while continuing to enrich global science with a distinctive Central Asian scholarly voice.

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Lexical Replacement and Core Vocabulary Stability in Language Evolution

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ABSTRACT

Language, as a dynamic and evolving system, undergoes continual changes at multiple levels, including phonology, morphology, syntax, and semantics. Among these, lexical change - specifically lexical replacement - offers unique insight into both the mechanisms of language evolution and the stability of linguistic systems over time. Lexical replacement refers to the phenomenon whereby words in a language's vocabulary are systematically replaced by alternative expressions, either from within the same language or through borrowing from other languages. Despite this flux, certain subsets of vocabulary, often termed core vocabulary, exhibit remarkable stability across centuries, providing a foundation for linguistic continuity and comparability.

Keywords: language evolution, word frequency, replacement rate, proto-language reconstruction, quantitative linguistics, lexical stability

Introduction

Lexical replacement occurs through various mechanisms, each driven by sociocultural, cognitive, and structural factors. Semantic shift is a common pathway, whereby an existing term gradually acquires new meanings, potentially leading to its replacement by a more precise or socially preferred synonym. Borrowing represents another major mechanism; words from contact languages may supplant native terms due to prestige, technological innovation, or cultural influence. For example, English has integrated numerous French and Latin loanwords following historical events such as the Norman Conquest. Phonological erosion and analogical change can also catalyze lexical replacement, as sound changes may render older forms less recognizable or usable.

While many lexical items are prone to replacement, a subset of basic words demonstrates notable stability. Core vocabulary typically includes terms denoting fundamental human experiences, such as pronouns (e.g., *I, you, he*), kinship (e.g., *mother, father*), numerals (e.g., *one, two, three*), body parts (e.g., *hand, eye*), and basic natural phenomena (e.g., *water, sun*). These words are less likely to be borrowed or innovated upon, possibly due to their central role in everyday communication and cognitive salience. This stability allows linguists to utilize core vocabulary as a metric in historical and comparative linguistics, aiding in the reconstruction of proto-languages and the establishment of language family trees.

Materials and methods

Recent advances in computational linguistics and large-scale lexical databases have enabled the quantification of lexical replacement rates. Studies employing Swadesh lists - a standardized set of core vocabulary items - demonstrate that the probability of replacement is not uniform across semantic domains. Words associated with basic human needs and experiences tend to have lower replacement rates, whereas culturally contingent terms such as technological, political, or religious vocabulary exhibit higher volatility. For instance, terms related to agricultural tools or modern technology evolve rapidly, reflecting changing societal contexts. Mathematical models of lexical evolution, including stochastic and phylogenetic approaches, provide predictive insights into replacement dynamics and language divergence.

The replacement rate of a word indicates how quickly it is likely to be substituted or replaced. Research demonstrates that: high-frequency words (e.g., *I*, *you*, *not*) tend to remain stable over centuries, showing very low replacement probabilities; culturally or technologically dependent terms (e.g., *plough*, *computer*, *internet*) exhibit higher volatility and are more likely to be borrowed or replaced. For example, the English term “computer” emerged in the 20th century and has remained stable, whereas newer technological terms, such as *smartphone* or *tablet*, evolve rapidly in response to innovations.

Modern computational methods allow researchers to model lexical replacement more systematically. Stochastic models treat word change as a probabilistic process, simulating the loss and replacement of words over time. Phylogenetic models create evolutionary “trees” of languages, showing which words remain stable and which are prone to replacement. These models help reconstruct proto-language forms and estimate divergence times among related languages.

Research by Pagel and others shows that there is an inverse correlation between word frequency and replacement rate, meaning that frequently used core vocabulary words remain highly stable, while less frequent, culturally specific terms change more quickly. Core vocabulary words can remain largely unchanged for 6,000 to 10,000 years, providing a solid foundation for historical linguistic reconstruction. In contrast, words tied to cultural or technological contexts exhibit much higher replacement rates, reflecting shifts in society and innovation [2].

Quantitative studies of lexical replacement provide insights into the historical development and tempo of language change, enable linguists to reconstruct proto-languages with greater accuracy and explain why certain semantic domains, particularly cultural or technological vocabulary, are more prone to rapid change.

Lexical replacement is also shaped by sociolinguistic factors, including language contact, social prestige, and identity construction. Communities often adopt new lexical items to signal modernity, cosmopolitanism, or affiliation with a particular social group. Cognitive constraints, such as ease of articulation, perceptual distinctiveness, and memory load, further influence which words are more likely to be retained or replaced. The interaction of these factors contributes to a delicate balance between innovation and stability in language evolution.

Social context heavily influences lexical change, and several sociolinguistic mechanisms contribute to lexical replacement. Language contact occurs when communities interact with speakers of other languages, leading to borrowing, where loanwords often replace native terms, particularly if the donor language carries higher prestige or cultural influence; for example, English incorporated a large number of French words following the Norman Conquest, especially in legal, administrative, and cultural domains, such as *court*, *judge*, and *government*. Social prestige and identity also play a role, as communities often adopt new lexical items to signal social status, modernity, or affiliation with a specific social group. Terms associated with technology, fashion, or education may replace older native words to reflect cosmopolitanism or sophistication. Cognitive constraints further shape which words are more likely to persist. Words that are simple to pronounce and clearly distinguishable from others are more likely to remain stable, whereas phonetically complex or easily confusable words are prone to analogical replacement. Additionally, words that are semantically transparent and easily memorized are less likely to be replaced, as cognitive efficiency favors the retention of highly accessible and meaningful vocabulary. Lexical replacement thus emerges from the interplay of social and cognitive forces: a word may be easy to remember cognitively but replaced due to social prestige, while a socially central term may be retained despite phonological complexity. For instance, the English word *father* remained stable due to both its cognitive salience and centrality in social life, whereas terms for modern inventions, such as *automobile*, are frequently borrowed or replaced because social and cultural factors outweigh cognitive stability. Understanding sociolinguistic and cognitive

influences allows linguists to predict which words are more likely to change in different communities, reconstruct historical lexicons more accurately by recognizing culturally driven replacements, and analyze language evolution not only as a structural process but also as a reflection of human behavior, cognition, and social dynamics.

Understanding the patterns of lexical replacement and the stability of core vocabulary is of paramount importance for historical linguistics and the reconstruction of earlier stages of languages. Lexical replacement provides a measurable record of how languages evolve over time, offering insights into which elements of a language are resilient and which are susceptible to change. By identifying and analyzing stable lexical items - particularly those belonging to core vocabulary - linguists are able to trace genealogical relationships among languages, even in cases where written records are limited, incomplete, or entirely absent. This approach allows researchers to reconstruct proto-languages, infer sound changes, and map out the evolutionary pathways that connect contemporary languages to their ancestral forms.

Moreover, recognizing the semantic domains that are prone to rapid replacement is equally critical. Certain categories of vocabulary, such as culturally specific or technologically derived terms, tend to change more frequently due to social innovation, contact with other languages, or shifts in cultural practices. Failing to account for the volatility of these lexical items can lead to misleading conclusions about language relationships or the timing of linguistic divergence. In contrast, core vocabulary - comprising words related to basic human experience, kinship, body parts, numerals, and fundamental natural phenomena - tends to remain remarkably stable across millennia. These words function as temporal anchors, providing reference points for comparative analysis and allowing linguists to detect systematic changes in sound patterns, morphology, and syntax across related languages.

The study of lexical replacement also enhances our understanding of the broader cultural and cognitive contexts in which languages develop. By comparing patterns of change across different linguistic communities, researchers can infer not only linguistic history but also aspects of social organization, contact dynamics, and cognitive constraints that shape communication. For example, the persistence of certain core words may reflect their central role in everyday human interactions, while the rapid evolution of specialized terminology may indicate shifts in technology, trade, or cultural influence. In sum, the interplay between stable and volatile vocabulary provides a multidimensional framework for reconstructing historical lexicons, understanding language evolution, and uncovering the deep history of human communication. Through careful analysis of lexical stability and replacement patterns, historical linguists can build more accurate models of language change, refine phylogenetic trees, and gain a richer appreciation of the dynamic forces shaping human language across time.

Conclusion

Lexical replacement and the stability of core vocabulary represent two intertwined and complementary dimensions of linguistic evolution, reflecting the dynamic tension between innovation and continuity within human languages. While the majority of a language's lexicon is constantly subject to change, driven by an array of social, cognitive, and structural factors, core vocabulary demonstrates remarkable resilience across centuries and even millennia. Words that denote fundamental aspects of human experience - such as personal pronouns, kinship terms, numerals, and references to essential natural phenomena - tend to remain stable due to their central role in communication, cognitive salience, and everyday usage. This stability provides a reliable framework, or scaffold, upon which languages can evolve, allowing speakers to maintain intelligibility and continuity even as other parts of the lexicon fluctuate.

The study of lexical replacement and core vocabulary stability is not only a descriptive enterprise but also a critical tool for understanding the broader mechanisms of language change.

By examining patterns of word retention and replacement, linguists gain insights into how languages adapt to shifting cultural contexts, technological innovations, and social dynamics. Moreover, these investigations illuminate the cognitive processes underlying language, revealing how factors such as frequency of use, ease of articulation, memory constraints, and perceptual distinctiveness influence which words endure and which are replaced. Sociolinguistic influences, including prestige, identity, and community interaction, further interact with these cognitive factors to shape the trajectory of lexical evolution, highlighting the intricate interplay between the human mind, social behavior, and linguistic systems.

In addition to advancing theoretical understanding, research into lexical dynamics has practical applications for historical and comparative linguistics. Core vocabulary stability enables the reconstruction of proto-languages, the establishment of genealogical relationships among language families, and the refinement of phylogenetic models. Conversely, analyzing rapidly changing lexical domains sheds light on cultural and technological developments, illustrating how language both reflects and shapes societal change. Contemporary computational and empirical methodologies - including phylogenetic modeling, stochastic simulations, and large-scale lexical databases - have further expanded the scope of this research, allowing for precise measurement of replacement rates, predictive modeling of language divergence, and the identification of cross-linguistic patterns that were previously undetectable.

Ultimately, the dual processes of lexical replacement and core vocabulary preservation underscore the remarkable adaptability and resilience of human language. They demonstrate that while languages are inherently dynamic and responsive to internal and external pressures, they also possess enduring elements that maintain continuity over vast historical timescales. Continued research in this field promises to deepen our understanding of linguistic evolution, providing increasingly sophisticated models that integrate social, cognitive, and structural perspectives. Such work not only enriches theoretical linguistics but also enhances our comprehension of human cognition, cultural transmission, and communication across generations, revealing the profound interconnection between language, thought, and society.

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ƏDƏBİYYAT DƏRSLƏRİNDƏ POEMA JANRINDA ƏSƏRLƏRİN TƏDRİSİ METODİKASI

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Xülasə

Müasir dünyamızda dərslük artıq yeganə bilik verən mənəbə deyil. Fəal/interaktiv təlim müəllim və şagirdin birgə iş aparmasını tələb edir. Kurikulumla hazırlanmış yeni dərslük, metodik vəsaitlər, lüğətlər və s. bu yolda atılmış uğurlu addımlardır. Hazırlanan yeni dərslük komplektləri, istifadə olunan yeni metodlar, İKT vasitələrindən dərslük prosesində istifadə olunması və s. ədəbiyyatın tədrisinə də öz müsbət təsirini göstərmişdir.

Azərbaycan ədəbiyyatında öz layiqli yerini tutan poemalar məktəblilərin vətənpərvərlik ruhunda yetişməsində, onların yüksək mənəvi-əxlaqi keyfiyyətlərə yiyələnməsində, bədii estetik zövqlərinin inkişaf etməsində əvəzsiz rol oynayır. Poemalarda qoyulan problemlər, təbliğ olunan məsələlərin böyük bir əksəriyyəti bu gün də öz aktuallığını qoruyub saxlayır. Bu əsərlərdəki dərin ideyalar hər zaman vacib və mühümdür. Məhz buna görə də, bu poemaların tədrisi şagirdlərin mənəvi dünyasını genişləndirmək baxımından çox böyük əhəmiyyət kəsb edir.

Məqalədə poemaların tədrisi zamanı nəzərə alınmalı məsələlərdən bəhs olunur.

Açar sözlər: metodika, ədəbiyyat, tədris, poema, janr.

Keywords: method, literature, teaching, poem, genre.

Ədəbiyyat incəsənətin bir qolu kimi insanın arzu və istəklərini, xəyallarını, düşüncələrini bədii şəkildə təsvir edir və onları həyat həqiqətləri ilə bu və ya digər dərəcədə əlaqələndirir. Ədəbiyyat da sanki bir ünsiyyət vasitəsi kimi hələ ən qədim dövrlərdən insanlar arasında əlaqə yaratmış, ayrı dildən, ayrı irqdən olan insanları eyni bir düşüncə və duyğu altında birləşdirə bilmişdir.

Bu gün fəal təlimin qarşısında duran ən başlıca vəzifələrdən biri də şagirdləri vətənpərvərlik ruhunda böyütmək, onlarda Vətənə, millətə, xalqa qarşı sevgi hisslərini inkişaf etdirməkdir. Ədəbiyyat bir fənn kimi məktəblilərin məhz bu aspektdə tərbiyə olunmasında müstəsna rola malikdir. İstər qədim dövrlərə aid ədəbi nümunələrimizdə, istərsə də sonrakı dövrlər ədəbiyyatımızda xalqımızın tarixi, adət-ənənələri, haqq-ədalət mübarizələri, sevgi, dostluq kimi hisslərin ülviliyi, müqəddəsliyi öz əksini tapmışdır.

Ədəbiyyat eyni zamanda şagirdlərin bir şəxsiyyət kimi formalaşmasında da mühüm rol oynayır. Ədəbiyyat vasitəsilə məktəblinin özünü, öz hisslərini tanıması asanlaşır. Yazıçının dünyagörüşü, həyata baxışı, düşüncələri bədii nümunələrdə öz əksini tapır. Bu nümunələr isə məktəblilərin öz mənəvi dünyasına səyahət etməsinə səbəb olur. Hər bir ədəbi nümunə konkret bir tarixi dövrü əks etdirir. Məhz buna görə də əsər üzərində iş aparılan zaman bu cəhətlərə xüsusi diqqət yetirmək lazımdır.

Azərbaycan ədəbiyyatında xeyli sayda poema vardır. Bu poemaların bəziləri sevgi-məhəbbət mövzusunda, bəziləri ictimai-siyasi mövzuda, bəziləri isə tarixi mövzudadır. Həmin əsərlər şagirdlərin vətənpərvər, ədalətli ruhda tərbiyə olunmasında xüsusi rol oynayır. Bütün bu sadalananlar poemaların tədrisi metodikasını düzgün müəyyənləşdirməyin vacibliyini gündəmə gətirir və bu tədqiqatın aktuallığının əsasını təşkil edir.

Poema tərənnüm və təhkiyə kimi əksətdirmə üsullarının birləşdiyi janrdır. Bəzi əsərlər özündə həm lirik, həm də epik növün xüsusiyyətlərini daşıyır. Bunlara qarışıq janr da deyilir. Poema və dastan janrını buna misal kimi göstərmək olar. Poemada hadisələr təhkiyə üsulu ilə söylənilirdi

kimi, həm də obrazların hiss və həyəcanları, arzuları, istəkləri də təənnüm üsulu ilə təsvir edilir. Məsələn, böyük şairimiz Məhəmməd Füzulinin “Leyli və Məcnun” poemasında əsas hadisələr vahid bir sujet xətti əsasında təsvir edilir. Lakin eyni zamanda, əsərdə qəhrəmanların daxili aləmini açmaq üçün lirik şeirlərdən də istifadə olunur. Bələliklə də, bu əsərdə epik təsvir ilə lirik təənnüm bir vəhdət təşkil edir. Əhvalatların epik təsvirinə daha çox yer verilən poemalar epik-lirik poemalar adlanır. Lirik hisslərin üstünlük təşkil etdiyi poemalara isə lirik-epik poemalar deyilir. Məsələn: Nizami Gəncəvinin “Xosrov və Şirin”, Məhəmməd Füzulinin “Leyli və Məcnun”, Ş.İ.Xətəinin “Dəhnamə” əsərləri epik-lirik, S.Vurğunun “Bəsti”, H.Cavidin “Azər”, H.Arifin “Yolda” poemaları isə lirik-epik növə aid nümunələrdir.

Azərbaycan ədəbiyyatında süjetsiz poemanın ilk nümunəsi Xaqani Şirvaninin “Töhfətül-İraqeyn” poeması hesab olunur. Ədəbiyyatımızda ilk süjetli poema nümunəsi isə Nizami Gəncəvinin “Xəmsə”yə daxil olan ikinci əsəri “Xosrov və Şirin” poemasıdır. Bu poemalardan bəziləri orta məktəbdə şagirdlərə tədris olunur.

Ümumtəhsil məktəblərinin 8-ci sinif ədəbiyyat dərsləklərində poema janrı barəsində şagirdlərə ətraflı məlumat verilmişdir. Bununla yanaşı, ədəbiyyat dərsləklərində böyük şairimiz Nizami Gəncəvinin “Sirlər xəzinəsi” poemasından “Sultan Səncər və qarı” hekayəsi, Şah İsmayıl Xətəinin “Dəhnamə” poemasından isə “Bahariyyə” hissəsi şagirdlərə tədris olunur.

Ədəbiyyat təliminin əsasını bədii əsərlərin öyrənilməsi təşkil edir. Bədii əsərin öyrənilməsinin əsas vasitələrindən biri isə təhlildir. Təhlildən əvvəl bədii əsərlər üzərində aparılan bütün iş növlərinin özünəməxsus məqsədi, xüsusiyyəti var və bunlar müəyyən dərəcədə müstəqil məşğələlər adlanır. Lakin bütün bu məşğələlər təhlil üçün giriş, başlanğıc mərhələsi rolunu oynayır.

Təhlilin müvəffəqiyyəti əvvəlki mərhələlərdə aparılan məşğələlərin keyfiyyətindən çox asılıdır. Təhlilin elementləri müəyyən dərəcədə giriş məşğələlərində, oxu prosesində, mətn üzrə aparılan başqa işlərdə və məzmunun mənimsədilməsində özünü göstərir. Lakin ədəbi əsərin ideya-bədii dəyərinin, obrazlar sisteminin, bədii dilinin, kompozisiyasının, üslubunun və başqa bədii xüsusiyyətlərinin tam mənada başa düşülməsi yalnız təhlil vasitəsilə mümkündür.

Təhlilin özünəməxsus prinsipləri vardır. Bu prinsipləri aşağıdakı şəkildə ümumiləşdirmək olar:

1. Tarixilik prinsipi
2. Məzmun və formanın vəhdəti prinsipi
3. Pedaqoji prinsip

Tarixilik prinsipi. Bədii əsərlərin təhlili zamanı tarixilik prinsipinə əməl olunması vacib məsələlərdəndir. Hər hansı bədii əsərdə yazıçının öz dünyagörüşü cəhətindən həyata olan münasibətini, müxtəlif ictimai hadisələri, cəmiyyətdə baş verən ictimai dəyişiklikləri və sairələri görə bilirik. Buna görə də təhlil zamanı müəllim əsərdə qoyulmuş məsələlərin hər iki tərəfini – təsvir olunanı və təsvir olunana yazıçının münasibətini sadə, aydın və proqrama uyğun bir şəkildə açıb göstərməlidir.

Ədəbi əsər həyatın inikası kimi müəyyən tarixi, ictimai dövrün məhsuludur. Buna görə də əsərin tarixi şəraitlə necə bağlandığını, onun tarixi-ədəbi fakt olaraq necə meydana çıxdığını, öz dövrünə və sonrakı dövrlərə təsirini aydınlaşdırmaq təhlil prosesinin mühüm tələblərindəndir.

Əsərin təhlilinə tarixilik nöqtəyi-nəzərindən yanaşmaq əsərlə orada əks olunan dövr və şərait, həmçinin yazıçı ilə onun yaşayıb-yaratdığı zamanə arasındakı üzvi əlaqəni müəyyənləşdirmək zərurəti ortaya çıxır. Şagirdlərin nəzərinə o da çatdırılmalıdır ki, müəyyən ictimai-tarixi dövrün məhsulu olan bəzi əsərlər öz zamanəsi üçün müsbət hadisə sayılıb, mütərəqqi rol oynadığı halda, həmin əsərlərdə irəli sürülən ideyalar sonrakı dövrlər üçün öz əhəmiyyətini ya tamamilə, ya da qismən itirir.

Məzmun və formanın vəhdəti prinsipi. Hər hansı bədii əsər məzmun və formanın vəhdətindən ibarətdir. Məzmun və forma hər hansı bir əşyanın və ya hadisənin iki tərəfi olub, bir-biri ilə ayrılmaz və üzvi şəkildə əlaqədardır.

Bədii əsərin məzmunu vaitəsi ilə müəyyən bir ideya təbliğ edilir, yəni məzmun əsərdə təsvir olunan həyat hadisələrindən və hadisələrə yazıçının münasibətindən ibarətdir. Başqa sözlə desək, əsərin məzmunu ictimai həyatın müəyyən hadisələri, insanları və əşyalarıdır ki, bunlarla əlaqəli olaraq yazıçı öz fikirlərini söyləyir və ideyalar sistemini yaradır.

Bədii əsərin digər elementlərini (sujetini, kompozisiyasını, obrazların dilini və s.) isə formaya aid etmək lazımdır. Əlbəttə ki, ədəbi əsərdə məzmun və forma arasında qoyulan bu sərhəd təxminidir, şərtidir. Çünki bəzi hallarda əsərin bəzi elementləri həm məzmunu, həm də formaya aid ola bilər.

Pedaqoji prinsip. Müəllim bədii əsərin təhlili ilə bağlı aparılacaq işi planlaşdırarkən yuxarıda göstərilən prinsiplərdən başqa, konkret əsərin təhlilindən doğan bütün pedaqoji tələb və imkanları da nəzərə almalıdır. Bu məqsədlə şagirdlərin ədəbiyyat üzrə bilik səviyyələri, əsərin yazılma tarixi və müəllimin özünün hazırlığı, pedaqoji proses və sairələr əsas tutulmalıdır. Bütün bunlar konkret bir əsərin təhlilinin məzmun və formasında bu və ya başqa bir şəkildə öz əksini tapmalıdır.

Bədii əsərlərin müxtəlif mövzuda, janr və növlərdə, üsul və üslublarda yazılmasına baxmayaraq, onların təhlili üçün ümumi olan bir sıra məsələləri qeyd etmək olar:

- a) mövzu;
- b) obrazlar;
- c) kompozisiya;
- d) bədii dil;
- e) ideya emosional məzmun;
- f) ədəbi janr;
- g) əsərin ictimai siyasi əhəmiyyəti.

Elmi-metodik ədəbiyyatda ədəbi əsərin təhlilinin aşağıdakı növləri göstərilir:

1. Müəllif arxasıya və ya kompozisiya üzrə
2. Obrazlar üzrə
3. Problem-mövzu üzrə

Əsərin öyrənilməsində hansı təhlil növünün seçilməsi əsasən aşağıdakı şərtlərdən asılıdır:

- a) Əsərin məzmunu, janr xüsusiyyəti, kompozisiya quruluşu
- b) Əsərin həcmi
- c) Şagirdlərin əsəri qavrama xüsusiyyəti, ədəbi inkişaf səviyyəsi
- d) Əsərin öyrənilməsində qarşıya qoyulan məqsəd
- e) Əsərin tədrisinə ayrılan vaxt

Müəllif arxasıya təhlil yolu əsərin kompozisiyası, sujeti əsasında gedir. Əsərdəki epizodlar üzərində iş geniş yer tutur. Ayrı-ayrı hadisələrin, müəllif şərhlərinin və sairələrin izahı əsərdəki əsas məsələlərin və ideyanın aydınlaşdırılmasına xidmət edir. Bu yol əsəri öz təbii halında emosional qavramağa, forma ilə məzmunu qarşılıqlı vəhdətdə öyrənməyə imkan verir.

Müəllif arxasınca təhlil yolunda əsərdəki hadisələri tək-tək nəzərdən keçirmək, onların bəzisi üzərində dayanıb izahat aparmaq lazım gəlir.

Obrazlar üzrə təhlil məktəbdə ən çox istifadə edilən üsuldur. Əsər bu yolla öyrənilərkən diqqət əsərdəki obrazlar üzərində cəmləşdirilir. Əsərin xüsusiyyətləri obrazların təhlili əsasında aydınlaşdırılır. Lakin obrazlar üzrə təhlil sadəcə obrazların xarakterinin təhlili demək deyil. Bu üsul obrazlar üzərində iş aparmaq əsasında əsərin ümumi problemlərini aydınlaşdırmağı, əsərin ideya-bədii məzmununu bütövlükdə qavramağı nəzərdə tutur.

Bədii əsərlərin tədrisi zamanı diqqət yetirilməli bir digər məqam da əsərin janr xüsusiyyətləridir. Müxtəlif janrlara məxsus əsərlər bir-birindən fərqlənirlər. Bu fərq əsərin məzmununda, həcmində və xüsusilə poetik quruluşunda özünü göstərir. Hər janra aid əsərin janr xüsusiyyətləri həm praktik yolla, yəni əsərin ayrı-ayrı əlamətlərini mənimsətmək yolu ilə, həm də ümumiləşdirmələr yolu ilə, yəni nəzəri məlumatları mənimsətmək yolu ilə öyrənilir.

Bədii əsərin öyrənilməsində ilkin mərhələ məzmunun mənimsənilməsidir. Hər bir ədəbi əsərin məzmunu son dərəcə zəngin və mürəkkəbdir. Əsərdə həyat dolğun bir şəkildə əks olunur. Yazıçı həyatı hadisələrin, insan həyatının ən xarakterik, tipik cəhətlərini sanki böyüdərək qabarıq şəkildə əks etdirir. Həm də bədii ümumiləşdirmələr apardığından əsərdəki əhvalat və hadisələr, epizodlar tutumlu, dolğun, çoxmənalı olurlar. Buna görə də belə hesab olunur ki, ədəbi əsərin məzmunu çoxqatlıdır. Bu qatların bəzisi üzdədir, onu hər kəs görüb dərk edə bilər. Elə qatlar isə vardır ki, onu qavrayıb dərk etmək üçün xüsusi iş aparmaq, fikirləşmək, tədqiqat aparmaq lazımdır. Məzmunun belə qatlarının dərk edilməsi əlavə biliklər və xüsusi şərtlər tələb edir.

Məzmunu mənimsəmə əsərlə sadəcə tanışlıq deyildir. Mürəkkəb və çətin prosesdir. Oxucunun şəxsi qabiliyyəti ilə şərtlənir və müəyyən mənada yaradıcı xarakterdə olur. Məzmunun öyrənilməsi prosesində şagirdlərin obrazlı təfəkkürü, təxəyyülü fəal olur. Bədii mətndəki sözlərin mənaları başa düşüb duyarkən onlara müvafiq assosiasiyalar yaranır, yeri gəldikdə əsərdəki hadisələri, epizodları sanki yaşayırlar.

Müəllim poemanın məzmunu üzərində iş zamanı iş növlərindən hansının seçilməsinə diqqətlə yanaşmalı və onun maraqlı keçməsinə hazırlıq görməlidir.

Mətni əzbər öyrəndərkən şagirdlərin fərdi qabiliyyətləri nəzərə alınmalıdır. Onların əzbər öyrənmək bacarığı müxtəlif cür olur. Bəziləri materialı bir-iki dəfə oxuduqda onu əzbərləyə bilər, bəziləri isə üç-dörd dəfə oxuduqda. Bəzilərinin isə əzbərləmə qabiliyyəti daha zəif olur.

Əzbərləmənin müəyyən şərtləri, texniki cəhətləri var ki, onlara əməl etdikdə əzbər öyrənmə və əzbər söyləmə daha səmərəli olur. İlk olaraq şagird əzbərləyəcəyi mətnə nədən söhbət getdiyini əvvəlcədən bilməli, mətnəki sözlərin, ifadələrin mənası onlara aydın olmalı, onlar mətni asanlıqla oxumağı bacarmalıdır. Sonra mətni hissələrə bölüb ayrı-ayrılıqda bir neçə dəfə oxuyub əzbərləmək lazımdır. Nəhayət, əzbərlənmiş mətn söylənərkən intonasiya tərzinə, vurğulara, pauzalara, surətə əməl olunmalıdır. Bu bacarıqlar sinifdə aparılan məşğələ prosesində şagirdlərə öyrədilməlidir. Yəni, əzbər öyrəniləcək mətn əvvəlcə oxunmalı, çətin söz və ifadələr izah edilməli, mətnin məzmununa uyğun oxu tərzini müəyyənləşdirilməlidir.

Şeiri əzbərlərkən onu hissələrə ayırmaq asandır. Çünki şeir bəndlərdən, beytlərdən ibarətdir ki, onların da hər biri həm məzmun, həm də forma cəhətdən əsasən bitkin olur. Buna görə də hər beyti, hər bəndi ayrıca əzbərləmək mümkündür.

Əzbərləmə prosesində mətnin yadda saxlanılmasına diqqət yetirməklə bərabər, onun məzmununa uyğun səsləndirilməsinə də diqqət yetirmək lazımdır. Nəsr əsərlərin, pyesdən parçaların əzbər öyrənilməsində və söylənilməsində də şeirlərə aid yuxarıda göstərilən cəhətlərə əməl olunmalıdır.

Əsərin tədrisində məzmunun öyrənilməsi priyomlarından yuxarıda göstərilən ardıcılıqla istifadə edilir. Lakin bu hər zaman belə olmur. Konkret tədris prosesində onların yeri dəyişə də bilər.

Yaxud məzmunun öyrənilməsi prosesində bir iş formasının müxtəlif növlərindən eyni vaxtda istifadə etmək mümkündür. Məsələn, məzmunun planı tərtib olunarkən sual-cavabdan, söz və ifadələrin izahından istifadə edilir və ya əsərin müəyyən hissəsinin məzmununu geniş şəkildə, yerdə qalan hissələrinin məzmununu isə qısa şəkildə planlaşdırılır. Beləliklə, bəzən əsərin məzmunu öyrənilərkən müxtəlif priyomlar bir-birinə qarışır, biri-digərinə vasitə olur, onlardan eyni vaxtda istifadə edilir.

Məzmunun öyrənilməsində istifadə olunan hər bir iş formasının ümumi, sabit cəhətləri vardır. Bununla yanaşı, tədrisdə istifadə edilərkən onlar bir çox şəkillərə düşür, müxtəlif çalarlı olurlar. Buna görə də həmin iş formalarına, onların tətbiqinə standart ölçülərlə yanaşmaq olmaz. Onlardan istifadə edərkən müəllim mətnin və tədris şəraitinin xüsusiyyətinə uyğun yaradıcı iş görməlidir.

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THE IMPACT OF ARTIFICIAL INTELLIGENCE ON MODERN FOREIGN LANGUAGE TEACHING

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This article provides a comprehensive examination of the transformational potential of artificial intelligence (AI) in foreign language instruction. In the modern educational system, AI technologies serve not only as tools for automating tasks but also as important means for developing students' individual abilities, increasing motivation, and making the learning process more efficient and adaptive. The article analyzes the use of AI platforms, adaptive learning systems, intelligent tutoring programs, automated lesson-planning tools, and interactive language applications in foreign language teaching. AI technologies offer learners personalized learning trajectories, enabling the development of grammar, vocabulary, listening, and speaking skills. In addition, virtual tutors and conversational agents play a significant role in enhancing language skills through interactive and practical activities. The article also discusses how AI supports teachers in the educational process by ensuring equal access to resources and providing adapted materials for learners of various proficiency levels. The studies discussed show that AI makes foreign language learning engaging, effective, and interactive, increases students' interest in languages, and supports autonomous learning. Moreover, AI provides equal access to quality education for learners in remote or resource-limited regions, thus improving the accessibility of language education. The article demonstrates that AI, complementing traditional pedagogical methods, contributes to improving instructional quality, offering personalized approaches, and effectively teaching linguistic skills and cultural values.

Keywords: artificial intelligence, foreign language teaching, language acquisition, adaptive learning, language skills, educational technologies, interactive learning, personalized learning, virtual tutors, automated lesson planning

РОЛЬ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В СОВРЕМЕННОМ ОБУЧЕНИИ ИНОСТРАННЫМ ЯЗЫКАМ

В данной статье всесторонне рассматривается трансформационный потенциал искусственного интеллекта (ИИ) в обучении иностранным языкам. В современной системе образования технологии ИИ выступают не только инструментом для автоматизированного выполнения заданий, но и важным средством развития индивидуальных способностей учащихся, повышения мотивации и повышения эффективности учебного процесса за счёт его персонализации и адаптивности. В статье анализируются возможности применения ИИ-платформ, адаптивных обучающих систем, интеллектуальных репетиторских программ, инструментов автоматизированного планирования уроков и интерактивных языковых приложений в процессе преподавания иностранных языков. Технологии ИИ предоставляют учащимся индивидуальные образовательные траектории, позволяя развивать грамматику, словарный запас, навыки аудирования и говорения. Виртуальные репетиторы и разговорные агенты играют важную роль в совершенствовании языковых навыков в интерактивной и

практико-ориентированной форме. В статье также рассматривается поддержка педагогов со стороны ИИ, обеспечение равного доступа к образовательным ресурсам и предоставление адаптированных материалов учащимся с разным уровнем подготовки. Исследования показывают, что ИИ делает процесс изучения иностранного языка более интересным, эффективным и интерактивным, повышает мотивацию учащихся и поддерживает их самостоятельное обучение. Кроме того, ИИ способствует обеспечению качественного образования для учащихся, проживающих в удалённых или ресурсно ограниченных регионах, что повышает доступность языкового обучения. Статья доказывает, что ИИ, дополняя традиционные педагогические методы, способствует повышению качества обучения, обеспечивает индивидуальный подход каждому учащемуся и эффективно способствует развитию языковых навыков и культурных компетенций.

Ключевые слова: искусственный интеллект, обучение иностранным языкам, языковое обучение, адаптивное обучение, языковые навыки, образовательные технологии, интерактивное обучение, индивидуальная траектория, виртуальные репетиторы, автоматизированное планирование уроков

Introduction

In recent years, artificial intelligence (AI) has begun to play an increasingly important role in education, including foreign language instruction. AI technologies offer learners personalized learning trajectories, enabling the development of grammar, vocabulary, listening, and speaking skills. Furthermore, virtual tutors, interactive chatbots, and adaptive learning platforms allow language skills to be improved through engaging and practical methods.

The effectiveness of foreign language teaching is closely related to learners' varying proficiency levels, limited resources, and the need for personalized instruction. AI is regarded as an effective tool for addressing these challenges. For example, intelligent systems provide real-time feedback, assist in correcting errors, and adaptive platforms offer materials tailored to each learner's pace.

In multilingual countries such as Kazakhstan, AI provides additional advantages in improving foreign language teaching. It enables learners to study Kazakh, Russian, and foreign languages in an integrated manner and makes learning engaging and accessible through multimedia and interactive materials [1]. In addition, AI eases teachers' workload by automating repetitive tasks, analyzing student progress, and enabling more purposeful and effective lesson delivery.

Furthermore, AI technologies complement traditional methods of language instruction, not only serving as technical tools but also enhancing learners' interest in languages while preserving cultural context. AI enriches language learning through interactive games, virtual dialogues, adaptive exercises, and audiovisual materials. These methods increase motivation and support the long-term retention of language skills.

Thus, AI is not merely a technological tool in foreign language teaching but an important instrument for developing learners' language abilities, enhancing motivation, and improving the overall learning experience.

Relevance

Foreign language learning has become one of the key priorities in education in today's globalized world. International experience shows that multilingualism enhances cognitive abilities, fosters creative thinking, and expands opportunities for international communication. Although traditional methods remain effective, they do not always fully adapt to individual learners' needs and learning pace. In such cases, artificial intelligence (AI) technologies prove their effectiveness.

AI platforms offer learners level-appropriate materials, provide interactive tasks aimed at developing grammar, vocabulary, listening, and speaking skills, and make the learning experience

more engaging. Moreover, virtual tutors and conversational agents make language learning enjoyable and practical, thus increasing learners' motivation [2].

In a multilingual country such as Kazakhstan, the role of AI is particularly significant. Kazakh, Russian, and foreign languages are used alongside each other, and learners' proficiency levels vary widely. AI technologies help overcome these challenges by offering personalized learning trajectories and delivering high-quality language materials to remote and resource-limited schools. Additionally, AI assists teachers by automating repetitive tasks, assessing student performance, and adapting lesson plans, thereby enhancing the efficiency of the learning process.

From this perspective, AI is highly relevant in foreign language instruction because it enables:

Here is the English translation:

1. **Takes into account students' individual abilities** – each learner can study at their own pace and develop both their strengths and weaknesses;
2. **Increases motivation** – interactivity and visual materials make language learning more engaging;
3. **Ensures accessibility** – provides high-quality resources even to schools in remote areas;
4. **Eases teachers' workload** – saves time by automating lesson planning, checking assignments, and providing feedback.

Artificial intelligence makes it possible to personalize instruction, address learners' needs through adaptive and interactive learning methods, and provide language learners with experiences close to real-life communication. Moreover, AI technologies can automatically assess students' knowledge and create personalized developmental trajectories [3].

AI plays an important role in the following areas of foreign language instruction:

1. **Creating personalized learning trajectories** – selecting materials, methods, and assessment tools that match each learner's individual needs and proficiency level. This increases student engagement and makes learning more effective [4].

Example:

In an English class, the teacher provides personalized materials according to learners' levels and interests by dividing students into three groups: beginner, intermediate, and advanced.

- **Beginner level:** Flashcards and picture-based exercises to teach everyday words and phrases, e.g., vocabulary building on the topic "Travel."
- **Intermediate level:** Dialogues and short texts to develop language skills, such as role-play activities on "Preparing for a Trip."
- **Advanced level:** Tasks focused on professional vocabulary and business communication, such as presentations on "International Business Negotiations."

At the end of the lesson, each group's work is assessed, and the teacher develops personalized plans for upcoming lessons. This approach supports engagement and improves learning outcomes [5].

2. Automatic assessment of language skills

AI systems offer one of the most significant advantages—automatic assessment. These systems accurately and efficiently track learners' progress using tests and tasks that evaluate grammar, vocabulary, pronunciation, and speaking skills.

Example:

Platforms like **Duolingo** assess speaking skills using speech-recognition technology. If a learner mispronounces a word, the system highlights the error and provides corrective suggestions. AI tools analyze written texts as well, detect grammatical and lexical mistakes, and offer recommendations.

Automatic assessment gives real-time feedback, helping students identify and improve weaknesses, while also easing the workload for teachers.

3. Dialogue platforms for speaking practice

AI-based dialogue systems offer a realistic communication environment, encouraging students to speak more actively [6].

Example:

Using ChatGPT, students can practice English conversation in scenarios such as booking a hotel, airport check-in, or shopping. The system corrects mistakes and provides tips on proper language use. Adaptive scenarios ensure students practice at an appropriate level, strengthening their confidence.

4. Gamification to boost motivation

Gamification introduces game elements to make learning more engaging. AI-powered platforms like **Duolingo** and **Memrise** incorporate points, levels, badges, and leaderboards. This fosters healthy competition and increases motivation.

Teachers can also use game-based activities and quizzes, divide students into teams, or reward learners with certificates or badges to increase engagement [7].

Modern AI-based methods in foreign language teaching

To effectively integrate AI tools into the classroom, teachers should consider the following recommendations:

- Choosing tools aligned with instructional goals
- Considering students' age and proficiency level
- Creating interactive tasks
- Using gamification elements
- Organizing practical speaking activities through chatbots
- Incorporating VR/AR tools
- Monitoring progress using AI analytics
- Redefining the teacher's role as facilitator and guide
- Providing continuous feedback
- Ensuring data privacy and safety

In conclusion, integrating AI into foreign language instruction enhances the efficiency of modern education. AI technologies support personalized learning, deepen language skills, and improve instructional quality. They make the learning process more engaging and elevate it to a new level. As AI becomes increasingly integrated into classrooms, interactive, creative, and effective teaching methods will continue to evolve [8].

Conclusion

In today's globalized world, foreign language acquisition is a crucial educational priority. With advances in artificial intelligence (AI), language learning has undergone significant transformation. Traditional methods cannot always fully account for individual learner differences and sometimes reduce motivation. From this perspective, AI offers effective and accessible solutions.

AI platforms and virtual tutors provide materials tailored to learners' proficiency levels, improving grammar, vocabulary, listening, and speaking skills. Adaptive learning systems make instruction more interactive and engaging. These methods boost interest in the language and support autonomous learning.

In multilingual countries such as Kazakhstan, the relevance of AI is particularly high. AI ensures equitable access to education, supports remote and resource-limited schools, and helps teachers save time through automation [9].

AI personalizes instruction, increases motivation, and complements traditional methods. Future research should explore AI's long-term effects on language retention and motivation, and

further develop platforms for diverse learner groups. Ultimately, AI modernizes the foreign language learning process and enhances its effectiveness.

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THE ROLE OF ARTIFICIAL INTELLIGENCE IN MODERN FOREIGN LANGUAGE TEACHING

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This article explores the pedagogical, technological, and methodological impact of Artificial Intelligence (AI) in contemporary foreign language teaching, offering an expanded and more detailed overview of how AI-driven solutions support the transformation of modern educational practices. It discusses various innovative digital tools that enable personalized learning, automated assessment, adaptive instruction, autonomous language practice, and enhanced accessibility for learners with diverse needs. The study provides an in-depth description of intelligent tutoring systems, speech recognition technologies, AI-based feedback generators, and adaptive learning platforms as essential components of digital language pedagogy. Furthermore, it highlights AI's contribution to learner motivation, inclusive education, and access to authentic linguistic input, demonstrating that when applied responsibly and ethically, AI significantly enhances teaching efficiency and supports the development of independent, confident, and digitally competent foreign language learners.

Keywords: Artificial intelligence; foreign language teaching; adaptive learning; digital pedagogy; automated assessment; language technologies; inclusive education

РОЛЬ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В СОВРЕМЕННОМ ОБУЧЕНИИ ИНОСТРАННЫМ ЯЗЫКАМ

Аннотация

В статье подробно и расширенно анализируется педагогическое, технологическое и методологическое влияние искусственного интеллекта (ИИ) на современное обучение иностранным языкам. Рассматриваются не только основные, но и дополнительные аспекты применения интеллектуальных обучающих систем, технологий распознавания речи, генераторов автоматической обратной связи и адаптивных образовательных платформ. Подчеркивается, что ИИ обеспечивает уникальные возможности для персонализированного обучения, способствует развитию автономной практики владения языком, повышает мотивацию обучающихся и делает образовательный процесс более доступным, гибким и ориентированным на индивидуальные потребности. Особое внимание уделяется усилению роли ИИ в поддержке инклюзивного образования, расширении доступа к аутентичным материалам и созданию цифровой образовательной среды, способствующей развитию цифровой грамотности. Полученные результаты демонстрируют значительный вклад ИИ в совершенствование современных педагогических стратегий и повышение эффективности обучения иностранным языкам.

Ключевые слова: Искусственный интеллект; обучение иностранным языкам; адаптивное обучение; цифровая педагогика; автоматизированная оценка; языковые технологии; инклюзивное образование

Theoretical Background

The theoretical foundations of integrating Artificial Intelligence into foreign language teaching are rooted in several influential pedagogical approaches that explain how technology can enhance learning processes. These theories provide a conceptual basis for understanding why AI tools are effective, how they support the development of communicative competence, and in what ways they complement existing instructional methods. The application of AI in language teaching is not random but aligned with established educational principles that emphasize interaction, personalization, and cognitive development. Each theoretical perspective contributes to framing AI as a meaningful and pedagogically appropriate tool for language acquisition.

1.1 Constructivism

Constructivism views learning as an active process in which learners construct their own understanding through direct engagement, experimentation, and reflection. Within this framework, AI technologies offer highly interactive environments that encourage students to explore language meaningfully. Digital tools such as intelligent tutoring systems and virtual communicative agents enable learners to engage in activities that require decision-making, problem-solving, and personal interpretation of linguistic input.

AI-based platforms generate real-time feedback, adaptive prompts, and supportive explanations, which help learners independently identify gaps in their knowledge and refine their understanding. This aligns with the constructivist idea that learning becomes deeper when individuals participate in authentic tasks and rely on personal discovery. By offering simulations, scenario-based dialogues, and context-rich exercises, AI strengthens the experiential aspect of language learning and promotes deeper internalization of linguistic structures [2].

1.2 Personalized Learning Theory

Personalized learning theory emphasizes that each student progresses differently, requiring instructional approaches tailored to their unique cognitive, linguistic, and emotional needs. AI is particularly aligned with this theory, as it uses algorithms to continuously analyze learner performance and adjust the learning path accordingly.

Adaptive systems can identify specific difficulties—such as grammar patterns, vocabulary gaps, pronunciation issues—and immediately modify the complexity or type of tasks to provide optimal learning conditions. This dynamic approach ensures that learners are neither overwhelmed nor underchallenged, helping maintain motivation and support steady improvement.

By reducing cognitive overload, AI supports mastery-based learning, where students move to new topics only after demonstrating a sufficient level of understanding of previous material. This reflects the theoretical belief that individualized pacing and targeted support significantly enhance long-term retention and academic success [6].

1.3 Sociocultural Theory

Sociocultural theory, grounded in the work of Vygotsky, highlights the central role of social interaction and guided support in language learning. According to this approach, learners develop linguistic competence through communication with more knowledgeable individuals or tools that provide scaffolding.

AI-driven chatbots, virtual tutors, and conversational systems fulfill this role by offering opportunities for continuous, interactive language practice. They provide models for correct language use, help learners express meaning, and give prompts that gradually move them toward more advanced linguistic structures.

Through these interactions, learners operate within the “zone of proximal development,” receiving assistance precisely when needed. AI thus acts as both a communication partner and a scaffold, helping students progress from basic to more complex linguistic forms. This digital support parallels traditional teacher-guided learning but extends it into a flexible, always-available format [3].

Research in recent years confirms the relevance of these theoretical frameworks. Doğan and Talan (2025) highlight that AI significantly influences the dynamics of language learning by providing data-driven insights and improving learner engagement [1]. Georgiou (2025) demonstrates that AI-powered pronunciation tools contribute to more accurate phonetic development and support autonomous practice [3]. Godwin-Jones (2024) emphasizes that generative AI enhances authenticity in digital learning settings by providing contextually rich tasks that reflect real-life communication needs [4].

2. Methodology

The methodology of this study is based on a systematic and multi-layered approach that allows for a thorough examination of the role of Artificial Intelligence in foreign language teaching. Although the research is primarily theoretical, it incorporates insights from empirical studies conducted in recent years within the fields of applied linguistics, digital pedagogy, and educational technology. The methodological structure includes a literature review, comparative analysis, and systematization of findings, which together form a comprehensive analytical framework.

2.1 Literature Review

The literature review involved an in-depth analysis of scholarly sources published between 2024 and 2025, a period characterized by rapid expansion in AI applications for language education. The review focused on identifying dominant themes, emerging trends, and common pedagogical implications associated with the integration of AI into instructional practice.

The selected sources include academic articles, empirical studies, theoretical papers, and technology reports that provide both conceptual and practical insights into AI-supported language learning. Through this process, the study identified key approaches to AI-enhanced assessment, adaptive learning systems, automated feedback mechanisms, virtual tutors, and conversational tools. These insights helped form a detailed understanding of how AI reshapes traditional teaching models and contributes to learner development [8].

2.2 Comparative Analysis

Comparative analysis was employed to examine different types of AI tools used in foreign language instruction. This method made it possible to evaluate how various technologies—such as speech recognition systems, adaptive platforms, writing evaluators, and chatbots—differ in their functions, technological complexity, and pedagogical value.

The analysis highlighted that each tool provides distinct advantages: speech recognition supports pronunciation accuracy, adaptive systems enhance personalized learning, writing evaluators improve grammatical and stylistic competence, while chatbots facilitate fluency through interactive communication. By comparing these tools, the study identified which pedagogical tasks are best addressed by specific AI technologies and how they contribute to overall learning outcomes [6].

2.3 Systematization

Systematization was used to organize the key findings from the literature review and comparative analysis into thematic categories. This method provided a structured understanding of AI's role in foreign language teaching and allowed the research to present a coherent overview of its main contributions.

Systematization made it possible to identify relationships between AI tools, pedagogical theories, learner needs, and instructional outcomes. As a result, the study developed a unified framework that explains how AI supports pronunciation training, writing development, adaptive instruction, communicative practice, material creation, and cultural competence.

The chosen methodology ensures that the research conclusions are grounded in current scientific evidence and aligned with contemporary trends in educational technology.

3. Analysis and Results

3.1 AI in Pronunciation Training

Speech recognition technologies have become particularly valuable in developing learners' pronunciation skills. These tools operate by analyzing spoken input, detecting phonetic deviations, and comparing learner pronunciation with native-like models.

AI-powered phoneme detectors and pronunciation analyzers offer immediate, highly detailed feedback that helps learners identify specific sounds, syllable stress patterns, rhythm, and intonation. Real-time correction accelerates skill development by allowing learners to adjust their pronunciation immediately rather than waiting for delayed instructor feedback.

Such systems also support repeated, independent practice, enabling students to build confidence and fluency without fear of making mistakes in front of peers. This fosters a low-stress learning environment conducive to phonetic improvement [3].

3.2 Adaptive Learning Platforms

Adaptive learning platforms use algorithms to analyze learner responses, difficulty patterns, and performance trends. Based on these data, the system adjusts the level of difficulty, content type, and task sequence to provide individualized learning experiences.

This personalized approach ensures that learners remain engaged and challenged at an appropriate level, reducing frustration and enhancing motivation. Adaptive platforms also help teachers by generating detailed reports that highlight learner strengths and weaknesses, enabling more targeted and effective instructional interventions [6].

3.3 Automated Writing Evaluation

Automated writing evaluation systems play a significant role in helping learners improve grammar, coherence, cohesion, lexical richness, and overall writing quality. These AI tools assess texts instantly and provide comprehensive feedback, including error identification, explanations, and suggestions for revisions.

Such systems encourage learners to revise their work multiple times, supporting the development of self-editing skills. They also allow students to practice writing more frequently, as they do not depend solely on teacher availability for feedback. This continuous practice contributes to long-term improvement in writing competence [8].

3.4 Conversational Chatbots

Conversational chatbots simulate real-life communication by engaging learners in dialogues that resemble authentic conversation. They offer limitless opportunities for practice, allowing students to interact in a safe, controlled environment where they can experiment with new vocabulary and structures.

Chatbots help reduce communication anxiety, support fluency development, and reinforce comprehension skills. They also expose learners to a variety of speech styles and conversational scenarios, expanding their communicative competence [3].

3.5 AI-Assisted Materials Development

AI offers powerful tools for generating instructional materials, including reading texts, vocabulary exercises, quizzes, grammar tasks, and differentiated resources. Teachers can create high-quality materials quickly, saving time and ensuring that activities are tailored to learner needs.

By automating content creation, AI reduces the teacher's workload and allows more time for mentoring, individual consultations, and interactive teaching. It also promotes consistency and variety in instructional design [5].

3.6 Cultural Competence Development

AI technologies provide access to multimedia resources such as videos, podcasts, interactive maps, and authentic texts from diverse cultural contexts. This exposure helps learners understand cultural norms, communication styles, and sociolinguistic nuances.

In a globalized world, cultural competence is a key component of language proficiency, and AI significantly enhances opportunities for learners to engage with real-world cultural content [2].

4. Discussion

The analysis demonstrates that AI plays an important role in enhancing motivation, accessibility, and instructional efficiency in foreign language teaching. These findings are consistent with earlier research emphasizing the growing importance of digital pedagogy and personalized learning approaches [1].

Despite its numerous advantages, AI integration also presents several limitations that need to be acknowledged.

First, AI cannot fully replicate the emotional connection, empathy, and intuitive decision-making that characterize human teacher–student relationships. Teachers remain essential for providing emotional support, fostering social interaction, and guiding learners through complex tasks [5].

Second, ethical concerns arise regarding data privacy, security, transparency, and potential algorithmic bias. These factors must be considered when implementing AI tools to ensure responsible use [4].

Third, many educators require additional training in digital literacy and AI-based instructional design. Without proper preparation, the effectiveness of AI tools may be reduced [7].

Fourth, automated systems sometimes provide inaccurate or overly generalized feedback, particularly in tasks requiring deep contextual understanding, such as creative writing or discourse interpretation [8].

Future developments should focus on improving AI accuracy, enhancing contextual understanding, expanding tool availability for multilingual environments, and strengthening teacher training programs. Ethical guidelines must also be established to ensure equitable and safe use of AI in education.

Conclusion

Artificial Intelligence plays a transformative and increasingly central role in modern foreign language teaching. It enhances access to individualized learning, supports communicative practice, improves the accuracy and efficiency of assessment, and contributes to the development of inclusive, adaptive instructional models.

AI complements rather than replaces teachers, helping automate routine tasks while allowing educators to focus on creative, interactive, and personalized teaching strategies. As technological innovation continues to evolve rapidly, AI is expected to further expand its role in education, shaping future approaches to language teaching and contributing to the development of autonomous, confident, and digitally competent learners.

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Philosophical Sciences

Socio-cultural aspects of interfaith interaction

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The socio-cultural aspects of interfaith interaction include relationships based on different values, worldviews, and religious experiences, which can both unite and divide different religious groups. Key aspects include finding common ground and considering differences that can lead to conflict or foster dialogue, as well as interaction at the cultural level, where the traditions, customs, and norms of different faiths are evident.

Religions are based on different values, which shape different worldviews. This can be both a source of disagreement and a basis for dialogue and mutual enrichment.

Differences in worldviews and religious experiences play an important role in interfaith relations, determining norms of behavior and perceptions of the world around them.

Interfaith relations are inextricably linked with cultural exchange, where different traditions, customs, rituals, and forms of spiritual life meet and interact. This interaction shapes the diversity of the cultural landscape. For sustainable interaction, it is important to find common ground, common traits, and values that can foster integration and harmony between faiths.

The inevitable existence of differences requires the development of mechanisms for conflict resolution based on respect and mutual understanding.

The state can play an important role in fostering a favorable interfaith climate by ensuring equality and non-discrimination.

Interethnic and religious relations, in their interconnectedness, arise through the activities and interactions of relevant social entities: ethnic groups and religious denominations, ethnonational and religious (confessional) groups, institutions and organizations, and individuals differing in their national and religious characteristics (identities). The nature of these relations, their direction, intensity, and the potential for conflict or, conversely, resolution and harmonization are largely determined by their internal specifics. The existence of multiethnic faiths in the form of world religions and monoethnic faiths in the form of national religions is a fact.

Despite integration, it was the 20th century that recognized the value of ethnic and religious diversity. Therefore, their moral interaction should proceed not through rigid defense of their own interests, but through dialogue between different nations and faiths. The growing role and significance of national and religious paradigms in the dynamics of modern society, associated with the actualization of stereotypes, typical attitudes, and the symbolic foundations of national identity, is linked to the dialectic of universal, ethnic, and religious values, while the stability of interethnic relations directly depends on the stability of the social system.

To stabilize social processes, interethnic and interfaith conflicts should be institutionally analyzed by translating them into legal and legislative frameworks. Legal influence on the relationship between the state and religious associations greatly contributes to the constructive resolution of emerging interethnic

and interfaith problems. This circumstance has determined the need to study the role and significance of religious organizations as an integral element of the system of state-faith relations, freedom of conscience as a philosophical and legal component of religious policy, and tolerance and a culture of peace as fundamental values of civil society.

Interaction is a strictly regulated sphere of human relations. Spheres of social activity defined by intangible categories (faith, traditions, customary lifestyles, ingrained behavior patterns, etc.) are difficult to regulate. The main reason is that, despite the existence of a legislative framework in this area, conflicts are resolved primarily through interaction between the parties and through agreements reached between them. A typical example of this type of conflict is interreligious conflict. The participants in this interaction are social groups whose members are united by faith, formulated doctrine, and ritual activity. They are characterized by a unity of ideological positions, a divine source defined by moral categories, a perception of the surrounding world, the fairways of social behavior and its evaluations, a high level of mysticism, and a certainty and relative categorical gradation in the «friend-foe» coordinate system. It should be noted that, as a rule, adherents of new religious movements are extremely categorical in their assessments, which often makes dialogue impossible. The key problem in resolving interfaith conflicts involving them is precisely that sectarians think within a predetermined framework, and any deviation from this framework is perceived as apostasy. There is no doubt, however, that only responsible (usually traditional) faiths can engage in interreligious dialogue, as the capacity for it is a sign of confidence in their values and meanings, their flock, openness to difference, courage to face spiritual challenges, and a lack of fear of competition, as well as the ability to reflect and comprehend. It seems that these parameters characterize the level of religious culture. A priori, the possibility of interfaith dialogue always exists. And it seems that two forms of dialogue can be distinguished. The first is based on the parties' recognition of the exceptional importance of interaction between different religions. It is built on the substantial experience of coexistence between faiths, as well as, possibly, the consequences of past conflicts. The empirical knowledge of behavioral standards, compromises, values, social patterns, historical precedents, etc. accumulated over decades ensures a sober perception of a given situation and the independent desire of the parties to resolve them, the ability to self-regulate interreligious dialogue and the ability to retouch deviations. Here, the process is essentially governed by an external norm, encouraging religious leaders to interact through the analects of interfaith culture. The second form is based on the regulatory function of the state, which encourages participants in an existing or potential interfaith conflict to cooperate. Authorized bodies are forced to intervene when established relations between denominations fail to serve as a foundation for dialogue, and norms of constructive social behavior are not perceived as imperative by the parties. And the less influence value-normative regulation has on the parties to the conflict, the greater the need for state intervention. This idea is supported by E.V. Romanova (Altai State University), who believes that «the construction of a model of two-way symmetrical communication in the form of dialogue, where each component-society, religious organizations, and government - is involved in the interaction process, will help avoid communication risks and ensure a stable and predictable system of interactions» [1].

Various religious traditions not only influence each other, but also interpenetrate their rituals, traditions, and core ideas. For example, in the Eurasian space, for centuries, there has been an exchange of Christian, Muslim, Buddhist, and Jewish cultures, as well as anachronistic polytheistic beliefs of indigenous peoples. In this regard, we agree with Zh.S. Syzdykova (Lomonosov Moscow State University), who, analyzing the ideas of L.N. Gumilyov, emphasizes «the existence of a super-ethnic integrity among the peoples of the Eurasian space, who... are united by mutual complementarity, that is, the complementarity of cultures, which exists despite certain differences in their way of life and behavior» [2]. Based on historical and biospheric prerequisites, the peoples of Eurasia have developed a common worldview, shared ideals in organizing social life, and a unique and inimitable unity in their sense of spirituality.

The evolving global economic situation is having a significant impact on stability within post-Soviet countries. A decline in the population's standard of living is a key factor catalyzing the emergence of social

tensions. These tensions typically manifest themselves in conflicts, one of the most likely of which in a multi-religious society is interreligious conflict.

They are particularly significant in the current situation of intensified global migration processes, when, amidst secularization, modernization, and cultural transformation, predominantly mono-confessional countries are directly confronted with the phenomenon of multi-confessionalism.

It should be noted that the growth of religious self-awareness among the populations of multi-confessional states, in addition to increasing the significance and influence of moral norms as a result of the implementation of religion's regulatory function, is creating a number of socially significant contradictions.

First, religious culture fosters intra-confessional consolidation and solidarity among believers, which can ultimately result not only in group cohesion but (under certain conditions) in social divisions accompanied by ideological differences.

Second, religious cultures have historically developed as macro-communities, to a certain extent opposing one another due to the influence of objectively existing «civilizational fault lines» that divide their followers. Third, localization through intra-confessional consolidation and solidarity, and the focus of believers exclusively on the values of their own religious cultures, in one way or another orients them toward interreligious differences, and thus actualize and shape in their consciousness the attitudes and concepts of social interperception, dividing the world into «us» and «them».

Meanwhile, the importance of cultural dialogue between religious faiths is indicated by the following directions of sociocultural change.

First, a peaceful resolution of ideological confrontation can lead to positive civilizational transformations, and strengthened ethnonational relations will become a reliable foundation for political stability.

Second, interfaith dialogue will hinder radicals' exploitation of the potential of religious ideology to mobilize the population through the actualization of various religious attitudes.

Third, dialogue between representatives of different faiths can become a guarantee of stability and the preservation of sociocultural self-identification in the context of globalization and identification.

Fourthly, interreligious dialogue provides an opportunity to once again be convinced that the origins of religious and political extremism and international terrorism cannot be formed within the depths of religious teachings.

The authors of most studies, to varying degrees, address the knowledge necessary for intercultural communication and the relationships that arise during communication, as well as skills (interpretation and correlation, discovery and interaction) and critical awareness of reality, and, based on these, competencies related to intercultural communication. The main advantage of the various approaches under consideration is their identification of two interrelated aspects of an individual's intercultural competence - the ability to understand one's native and foreign cultures. Another positive aspect is the establishment or recognition of the connection between thinking and behavior, which elevates intercultural competence to a more conscious, cultural, and philosophical level. Knowledge in the general concept of the culture of interethnic and interfaith communication includes awareness of the history, culture, customs and traditions of the nation, the characteristics of social groups participating in communication, the analysis of their practical activities, and the general processes of social and personal interaction.

Its prevention and resolution (if they arise) depend on the ability of both leaders and parishioners of opposing faiths to engage in interreligious dialogue. A multinational people living in a single state (as in Kazakhstan) has every reason to both build and coexist in a tolerant society. This is also facilitated by the common Eurasian mentality that has emerged as a result of the mutual enrichment of cultures.

The interaction of responsible faiths and their cooperation in the name of peace is an important component of the formation of a unified cultural and historical space as a unique civilizational phenomenon that facilitates interreligious communication.

A critical awareness of reality, including culture, political structure, the educational system, and other elements of social life, manifests itself in the ability, on the one hand, to critically perceive the worldview, activities, and results inherent in one's own and other cultures based on specific criteria, while, on the other hand, avoiding comparing and evaluating these phenomena, as each is valuable and significant in its own right. Thus, a culture of interethnic and interfaith communication presupposes the development of certain personal qualities: the ability to see the interconnections between different cultures (both external and internal); the ability to mediate and interpret one culture in terms of another; a critical and analytical understanding of one's own and other cultures; and an awareness of the determinism of one's own worldview by cultural and ideological traditions. This set of qualities leads to the development of a culture of interethnic and interfaith communication and determines the productivity and effectiveness of the work of a specialist in the field of interethnic relations and the comfort of any communicator who finds themselves in a foreign cultural environment. In our opinion, the culture of interethnic and interfaith communication should be understood as a set of specialized knowledge and beliefs, as well as corresponding actions and deeds, manifested both in interpersonal contacts and in the interactions of entire ethnic and religious communities. This culture, based on intercultural competence, allows for the rapid and painless achievement of mutual understanding and agreement in the common interest.

Intercultural competence, on which the culture of interethnic and interfaith communication is built, is a complex entity that includes, among other things, certain knowledge, qualities, skills, and abilities. In this regard, in terms of content, the culture of interethnic and interfaith communication includes the following main elements: knowledge, ideological, and behavioral components. Since the author provides a detailed analysis and characterization of the components in a series of publications, I will only name them in this article. First of all, it is necessary to note the knowledge component, which includes: history, culture, religion, traditions, and customs of one's own people; history and culture, religion, traditions, and customs of the communication partner; the place of history, culture, religions, traditions, and customs of one's own people and partners in world culture; the normative base by which a particular society, into which a migrant or communicator finds himself, lives; the language of the native ethnic group and the languages of interethnic and international communication (bilingualism and multilingualism); The characteristics of national culture as an expression of national psychology, the norms and rules that govern relationships between representatives of different ethnic communities or their development in mutual interests.

An essential feature of the culture of interethnic and interfaith communication is ideological conviction, which allows not only to reflect on the complex problems of social life and one's place in the world, but also to make independent decisions without being influenced by the circumstances of another culture or another person (an internally oriented, free, or autonomous personality). Therefore, the next component is the ideological aspect of the culture of interethnic and interfaith communication, which includes: the ability to resist the antipodes of the culture of interethnic and interfaith communication – narrow-mindedness and isolation, prejudice and hostility, mistrust and alienation, egoism and ethnocentrism, national vanity and arrogance; Socially and professionally oriented reactions to the character, style, and behavioral characteristics of people of other nationalities and religions; the need to establish in practice mutually agreed-upon principles of conflict-free understanding and cooperation in the course of interethnic and interfaith interaction. Intercultural competence presupposes that an individual not only navigates the four (mega, macro, meso, and micro) levels of understanding contemporary problems, but also actively participates in their resolution.

Regarding the interfaith situation in Kazakhstan, Kazakh scientists wrote: «Maintaining interfaith and interethnic peace can only be built on collaborative relationships between the state and religious associations. In this regard, Kazakhstan, home to over 100 nations and peoples speaking different languages, has not only managed to maintain peace within its own territory but also to strengthen and develop internationally. Modern Kazakhstan is also characterized by the equal coexistence of various religions, a balance between them maintained through the development of equal public policy for all faiths

and the fostering of a culture of tolerance based on equality before the law. Thanks to a well-thought-out national policy, new interethnic and interfaith relations are being established in modern Kazakhstan, creating the preconditions for the formation of a multiethnic and multi-faith community of Kazakhstanis with shared goals, ideals, and values. Rethinking the dialectical relationship between ethnic and religious aspects in Kazakhstani culture, their manifestation in mentality, lifestyle, social memory, and the process of self-identification, is becoming particularly relevant» [3].

In different regions of a multinational state, the culture of interethnic communication, as Z. Gasanov [4] rightly notes, has its own characteristics determined by the socio-historical past of the nation, the history of its relations with other peoples, the ethnopsychological compatibility of representatives of certain peoples, and religious and confessional specifics. However, one way or another, the culture of interethnic and interfaith communication can only be formed on the basis of solid knowledge, ideological culture, and psychological readiness, which constitutes the basis of intercultural competence - such a degree of manifestation of knowledge, skills, and abilities that allows one to correctly assess the specifics and conditions of interaction, relationships, and communication with representatives of specific ethnic communities, to see the uniqueness of traditions, habits, and psychological qualities manifested in their course, and to find adequate forms of influence on them in order to maintain an atmosphere of harmony, integrity, and mutual trust.

Therefore, it is important to develop at least a basic understanding of interethnic, interfaith, and international relations among the population of a multinational state, and to give them an understanding of the culture, traditions, and customs of the peoples inhabiting the country, republic, region, or specific locality. A culture of interethnic and interfaith communication can be formed based on the principles of social partnership among peoples, equality of people regardless of their nationality or religious affiliation, internationalism, collectivism, and democracy.

The culture of interethnic and interfaith communication does not represent the achievement of some specific goal; it is a permanent process of ascent to new heights of the culture of communication, the basis of which, on the one hand, is the knowledge, worldview and behavioral components, and on the other, a free, internally oriented personality.

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Psychological Sciences

İSTEDADLI UŞAQLARIN İNKLÜZİV TƏHSİLƏ CƏLB EDİLMƏSİ

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INVOLVING GIFTED CHILDREN IN INCLUSIVE EDUCATION

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XÜLASƏ

İstedadlı uşaqların inklüziv təhsil mühitinə inteqrasiyası müasir pedaqogikada mühüm əhəmiyyət daşıyır və onların həm akademik nailiyyətlərini, həm də harmonik inkişafını dəstəkləyir. Bu məqalədə istedadlı şagirdlərin inklüziv təhsildə təlim ehtiyacları, fərdi təhsil planlarının hazırlanması, diferensial və fərdiləşdirilmiş təlim strategiyaları, motivasiya və dəstək mexanizmləri nəzərdən keçirilir. Müəllimlərin, valideynlərin və psixoloqların birgə əməkdaşlığının əhəmiyyəti vurğulanır, çünki bu əməkdaşlıq uşağın fərdi potensialını müəyyən etməyə, onun sosial və emosional rifahını dəstəkləməyə imkan yaradır. Məqalədə istedadlı uşaqların inklüziv siniflərə adaptasiya zamanı qarşılaşdıqları akademik, sosial və emosional çətinliklər də təhlil edilir və bu problemlərin həlli üçün səmərəli strategiyalar təklif olunur. Tədqiqat göstərir ki, inklüziv təhsil mühiti və məqsədyönlü pedaqoji yanaşmalar istedadlı uşaqların intellektual inkişafını, sosial inteqrasiyasını və emosional sabitliyini dəstəkləyir. Nəticədə, inklüziv strategiyaların uğurla tətbiqi istedadlı uşaqların potensialını tam şəkildə reallaşdırmasına və cəmiyyətdə fəal, bərabərhüquqlu iştirakına şərait yaradır.

ABSTRACT

The integration of gifted children into inclusive education represents a crucial aspect of modern pedagogy, aiming to support both their academic achievements and holistic development. This study examines the theoretical and practical foundations of inclusive education for gifted students, highlighting the importance of individualized learning plans, differentiated instruction, and motivation and support mechanisms. The role of teachers, parents, and psychologists in facilitating effective educational strategies is emphasized, as their collaboration ensures the identification of students' unique abilities and provides necessary emotional and social support. Furthermore, the paper discusses the challenges gifted children face in adapting to inclusive classrooms, including academic, social, and emotional difficulties, and suggests practical solutions to enhance their engagement and well-being. The findings indicate that an inclusive educational environment, combined with targeted pedagogical approaches, promotes not only intellectual growth but also social integration and emotional stability for gifted learners. Ultimately, the successful implementation of inclusive strategies enables gifted children to fully realize their potential while participating actively and equally in society.

AÇAR SÖZLƏR: istedadlı uşaqlar, inklüziv təhsil, fərdi təhsil planı, motivasiya və dəstək, sosial inteqrasiya, fərdiləşdirilmiş təlim, müəllim və valideyn əməkdaşlığı

KEYWORDS: gifted children, inclusive education, individualized education plan, motivation and support, social integration, differentiated instruction, teacher–parent collaboration

Giriş

Müasir təhsil sistemində istedadlı uşaqların inkişafı və onların inklüziv təhsil mühitinə inteqrasiyası mühüm pedaqoji prioritetlərdən biridir. Inklüziv yanaşma yalnız fiziki iştirak və bərabər təhsil imkanları ilə məhdudlaşmır, həm də hər bir uşağın fərdi potensialını üzə çıxarmağa, onun sosial və emosional inkişafını dəstəkləməyə yönəlmişdir (Şıxlı, 2019; Həsənov, 2020). İstedadlı uşaqlar, müəyyən sahələrdə yüksək intellektual və yaradıcı qabiliyyətlərə malik olduqlarından, onların təlim ehtiyacları digərləri ilə müqayisədə fərqlənir və buna görə də xüsusi yanaşma tələb olunur.

Bu uşaqların inklüziv siniflərdə təlimi yalnız akademik biliklərin artırılması ilə kifayətlənməyib, onların yaradıcılıq bacarıqlarının, sosial inteqrasiyasının və emosional sabitliyinin inkişafına da xidmət edir (Rüstəmov, 2017; Məmmədova, 2022). Təlim prosesində fərdi təhsil planları, motivasiya və dəstək mexanizmləri, müəllim-peşəkarlığı və valideyn-məktəb əməkdaşlığı əsas vasitələr kimi çıxış edir (Əliyeva, 2018; Qasımova, 2018; İsmayılov, 2019).

Beləliklə, istedadlı uşaqların inklüziv təhsilə cəlb edilməsi həm fərdi, həm də sosial inkişaf baxımından çoxşaxəli və kompleks bir prosesdir. Bu məqalədə istedadlı uşaqların inklüziv təhsildə təlim ehtiyacları, fərdi təhsil planlarının hazırlanması, müəllim və valideyn rolu, motivasiya və sosial inteqrasiya aspektləri nəzərdən keçiriləcək, onların akademik və sosial inkişafının təmin edilməsinə yönəlmiş strategiyalar təqdim olunacaq.

Tədqiqat

Inklüziv təhsil modelinin əsas məqsədi şagirdlər arasında ayrı-seçkiliyi aradan qaldırmaq və hər bir uşağın potensialını maksimum səviyyədə inkişaf etdirməkdir. Inklüziv təhsilin əsas prinsiplərindən biri bərabər təhsil imkanlarının təmin edilməsidir ki, bu da istedadlı uşaqların xüsusi ehtiyaclarını nəzərə almağı tələb edir. Bərabər imkan prinsipi yalnız fiziki iştirakla məhdudlaşmır, eyni zamanda təlim mühitində əlavə resurslar, fərdi proqramlar və psixoloji dəstəyin təmin olunmasını da əhatə edir.

Inklüziv təhsil həmçinin fərdiləşdirilmiş və diferensiaslaşdırılmış təlimin tətbiqini zəruri edir. Bu yanaşma istedadlı uşaqların yüksək idrak sürətinə uyğun fəaliyyətlərin təşkilinə imkan verir. Fərdiləşdirilmiş təlim şagirdin maraq dairəsinə, qabiliyyətinə və inkişaf səviyyəsinə uyğun materialların seçilməsini tələb edir ki, bu da monotonluq və təkrarlardan yaranan motivasiya itkisini önləyir.

İstedadlı uşaqların təlim ehtiyacları digər şagirdlərdən fərqlənir; onların intellektual inkişaf sürəti daha yüksəkdir və mücərrəd düşünmə, problem həll etmə qabiliyyətləri erkən yaşda formalaşır. Bu səbəbdən onlara təqdim olunan tapşırıqlar daha mürəkkəb, araşdırmaya yönəlik və yaradıcı olmalıdır. Eyni zamanda, bu uşaqların sosial-emosional xüsusiyyətləri də xüsusi diqqət tələb edir, çünki bir çoxu yaşdqları ilə münasibətlərdə çətinlik çəkə, özlərini fərqli hiss edə və ya daxili gərginlik səbəbindən sosial təcrid ola bilər. Onların emosional sabitliyini qorumaq üçün inklüziv sinifdə dəstək mühiti yaradılmalı və müəllim fərdi ifadə imkanlarını genişləndirən metodlardan istifadə etməlidir.

Əgər istedadlı uşaqların inklüziv sinifə adaptasiyası üçün effektiv strategiyalar tətbiq olunmazsa, onlar təlimdən uzaqlaşa və ya potensiallarını tam göstərə bilməzlər. Bu baxımdan sürətləndirmə proqramları xüsusi əhəmiyyət kəsb edir, çünki bu uşaqlar tədris materialını daha sürətlə mənimsəyir və sürətli öyrənmə onlara daha uyğun gəlir. Sürətləndirmə sinfi atlama, mövzulara erkən giriş və əlavə dərslərin təşkili şəklində həyata keçirilə bilər.

Bundan əlavə, gücləndirilmiş təlim planları istedadlı uşaqların maraqlarını genişləndirməyə və analitik, yaradıcı bacarıqlarını inkişaf etdirməyə yönəlmiş xüsusi proqramlardır. Bu proqramlar çətin tapşırıqlar, layihələr, tədqiqat fəaliyyətləri və yaradıcı işləri əhatə edir. Inklüziv sinifdə gücləndirilmiş

təlim planlarının tətbiqi uşağın həm intellektual, həm də sosial inkişafını balanslı şəkildə dəstəkləyir. Müəllim bu planları uşağın inkişaf sürətinə uyğun qurur və materialları addım-addım çətinləşdirir. İnküziv sinifdə istedadlı uşaqlar üçün fərdi təhsil planlarının (FTP) hazırlanması müasir təhsil sistemində əhəmiyyətli proseslərdən biridir, çünki bu yanaşma hər bir şagirdin fərdi potensialını üzə çıxarmağa imkan yaradır. Fərdi yanaşmanın rolu ondan ibarətdir ki, müəllim hər bir istedadlı uşağın bilik səviyyəsini, maraqlarını, qabiliyyətlərini və inkişaf sürətini ayrıca qiymətləndirərək ona uyğun təlim strategiyası formalaşdırır. Bu, uşağın təlimə motivasiyasını artırır və onun istedadının itirilməsinin qarşısını alır. Həmçinin, fərdi yanaşma inküziv mühitdə müxtəlif səviyyəli şagirdlərin harmonik şəkildə birlikdə inkişaf etməsinə şərait yaradır.

İstedadlı uşaqların təlim ehtiyacları digər şagirdlərdən fərqləndiyi üçün fərdi təhsil planının hazırlanması labüddür. Bu baxımdan FTP-nin strukturu xüsusi önəm kəsb edir və onun əsas komponentləri dəqiq müəyyən edilməlidir. FTP-nin əsas elementlərinə məqsədlərin formalaşdırılması, təlim vəzifələrinin müəyyənləşdirilməsi və davamlı monitorinq sisteminin qurulması daxildir. Məqsədlər uşağın potensialına uyğun olaraq qısamüddətli və uzunmüddətli perspektivdə planlaşdırılır. Təlim vəzifələri bu məqsədlərə çatmaq üçün konkret addımları əhatə edir və uşağın bilik və bacarıqlarını mərhələli şəkildə inkişaf etdirir. Monitorinq isə uşağın təlim prosesində irəliləyişini daim izləməyə və lazım gəldikdə plana düzəliş etməyə imkan verir. FTP-nin strukturlaşdırılması həmçinin təlim prosesinin sistemli və şəffaf şəkildə həyata keçirilməsini təmin edir.

İstedadlı uşaqlarda təlim məqsədlərinin müəyyənləşdirilməsi FTP-nin ən vacib hissələrindən biridir, çünki onların inkişaf istiqaməti məhz bu məqsədlər əsasında müəyyən olunur. Akademik üstünlüklərə malik uşaqlar üçün məqsədlər daha mürəkkəb məzmunu, yüksək səviyyəli düşünmə bacarıqlarını və analitik təfəkkürü əhatə edən fəaliyyətləri əhatə etməlidir. Bu məqsədlər uşağın bilik səviyyəsini artırmaqla yanaşı, onun yeni mövzuları daha dərinlən öyrənmək bacarığını da inkişaf etdirir. Yaradıcı istedadlı uşaqlar üçün isə məqsədlər innovativ düşüncə, təsəvvür və problem həll etmə qabiliyyətlərini gücləndirməyə yönəldilir. Bu uşaqlar üçün tədqiqat layihələri, yaradıcılıq tapşırıqları, eksperimentlər və sərbəst fəaliyyətlər xüsusi əhəmiyyət daşıyır. Təlim məqsədlərinin düzgün müəyyən edilməsi uşağın həm akademik, həm də yaradıcı sahədə balanslı inkişafını təmin edir.

Fərdi təhsil planlarının hazırlanmasında müəllim və psixoloqun rolu böyükdür, çünki bu proses multidissiplinar əməkdaşlıq tələb edir. Müəllim uşağın təlim ehtiyaclarını müəyyən edən əsas şəxs olaraq fərdi planın strukturunu hazırlayır və ona uyğun metod və strategiyalar seçir. Psixoloq isə uşağın emosional vəziyyətini, sosial davranışını, özünəinamını və motivasiyasını qiymətləndirərək müəllimə istiqamət verir. Multidissiplinar komanda həmçinin valideynlərin də bu prosesə cəlb edilməsini nəzərdə tutur, çünki ailə uşağın inkişafında mühüm rol oynayır. Komanda uşağın güclü tərəflərini aşkar edir, çətinliklərini müəyyənləşdirir və ona uyğun təlim mühiti formalaşdırır. Müəllim və psixoloqun əməkdaşlığı sayəsində istedadlı uşağın təlim zamanı qarşılaşa biləcəyi problemlər vaxtında aşkarlanır və səmərəli şəkildə həll olunur.

Beləliklə, fərdi təhsil planlarının hazırlanması inküziv mühitdə istedadlı uşaqların təhsilini həm daha məqsədyönlü, həm də daha uğurlu edir. Bu yanaşma uşağın şəxsiyyət kimi inkişafına xidmət edir və onun gələcəkdə cəmiyyətdə öz yerini daha rahat tapmasına şərait yaradır.

İstedadlı uşaqların inküziv təhsilə cəlb olunmasında müəllimin rolu həm pedaqoji, həm sosial, həm də psixoloji baxımdan önəmli əhəmiyyətə malikdir və buna görə müəllim təhsil prosesinin əsas dayaqlarından biri hesab edilir. Müəllim yalnız bilik ötürən şəxs deyil, eyni zamanda uşağın istedadını vaxtında müəyyən edən, onu yönləndirən və inkişafını davamlı dəstəkləyən bir rəhbərdir. İstedadlı uşaqların fərdi xüsusiyyətlərini və öyrənmə sürətini nəzərə almaq üçün müəllim yüksək müşahidə qabiliyyətinə və pedaqoji çevikliyə malik olmalıdır. Müəllimin əhəmiyyəti ondan ibarətdir ki, inküziv sinifdə müxtəlif səviyyəli şagirdlərin birlikdə öyrənmə prosesini səmərəli və balanslı şəkildə təşkil etmək məhz onun peşəkarlığından asılıdır. Əgər müəllim uşağın güclü tərəflərini erkən

mərhələdə müəyyən edərsə, bu, onun potensialını daha tam və sürətli şəkildə inkişaf etdirməsinə imkan yaradır. Müəllimin dəstəyi olmadıqda isə istedadlı uşaqlar təlimdən uzaqlaşsın, motivasiyasını itirə və ya öz qabiliyyətlərini gizlətməyə başlaya bilərlər.

Müəllimin peşəkar bacarıqları istedadlı uşaqlarla işləməkdə xüsusi rol oynayır, çünki bu proses həm elmi bilik, həm də metodik ustalıq tələb edir. Diferensial təlim bacarığı müəllimin əsas kompetensiyalarından biridir və sinifdə müxtəlif öyrənmə tərzinə malik şagirdlərə fərqli səviyyədə tapşırıqlar təqdim etməyə imkan verir. Diferensial təlim istedadlı uşaqlara daha mürəkkəb, araşdırmaya yönəlmiş və yaradıcı fəaliyyətlər təklif etməyə şərait yaradır ki, bu da onların monoton təlim mühitində sıxılmasının və motivasiya itkisi yaşamasının qarşısını alır. Müəllimin digər vacib kompetensiyası istedadın aşkar edilməsidir. İstedadlı uşaq hər zaman dərhal seçilmir, bəzən öz bacarıqlarını gizlədə və ya diqqət çatışmazlığı səbəbindən fərqlənməyə bilər. Müəllim uşağın davranışını, maraqlarını və problem həll etmə qabiliyyətini diqqətlə müşahidə edərək onun hansı sahədə üstünlük göstərdiyini müəyyən edə bilər. Bu proses uşağın gələcək inkişaf yolunun düzgün qurulmasına xidmət edir.

Inklüziv sinifdə təlim metodlarının düzgün seçilməsi müəllimin rolunu daha da önə çıxarır. Layihə əsaslı öyrənmə istedadlı uşaqlar üçün ən səmərəli metodlardan biri hesab olunur, çünki bu yanaşma onların yaradıcılığını, analitik təfəkkürünü və komanda ilə işləmə bacarığını inkişaf etdirir. Layihə əsasında öyrənmə zamanı uşaq müstəqil araşdırma aparır, məlumatları təhlil edir və nəticələr çıxarır ki, bu da onun idrak potensialını artırır. Tədqiqat yönümlü tapşırıqlar isə istedadlı uşaqların məntiqi düşünmə və problem həll etmə bacarıqlarını inkişaf etdirir. Belə tapşırıqlar uşağın sual vermə, araşdırma aparma və nəticə çıxarma qabiliyyətini gücləndirərək onu daha fəal və müstəqil öyrənənə çevirir. Müəllim bu metodları tətbiq etməklə inklüziv sinifdə ümumi öyrənmə mühitini zənginləşdirir və eyni zamanda istedadlı uşaqların xüsusi təhsil ehtiyaclarını qarşılayır.

İstedadlı uşaqların inklüziv təhsil sisteminə cəlb olunmasında müəllim–şagird–valideyn əməkdaşlığı həlledici rol oynayır. Valideynlərlə sıx əlaqədə olan müəllim uşağın evdəki davranışları, maraqları və bacarıqları haqqında ətraflı məlumat əldə edə bilər ki, bu da təlim prosesinin effektivliyini artırır. Məlumatların paylaşılması təhsil mühitində bütün iştirakçıların məlumatlı olmasına xidmət edir və təlim strategiyalarının məqsədyönlü qurulmasına şərait yaradır. Müəllim, şagird və valideyn arasında güclü ünsiyyətin qurulması uşağın təhsil prosesində bütün tərəflərin aktiv iştirakını təmin edir. Motivasiya mexanizmləri də inklüziv sinifdə xüsusi əhəmiyyət kəsb edir. Müəllim istedadlı uşaqların motivasiyasını yüksəltmək üçün onların uğurlarını qeyd etmək, müsbət qiymətləndirmə tətbiq etmək və yaradıcılıq fəaliyyətlərini nümayiş etdirmək kimi vasitələrdən istifadə edə bilər. Bu, uşağın təlimdə və sosial fəaliyyətlərdə daha fəal olmasına və özünəinamının möhkəmlənməsinə kömək edir.

Nəticə etibarilə, müəllimin rolu istedadlı uşaqların inklüziv təhsil mühitində uğurla iştirak etməsi üçün əvəzsizdir. Müəllim yalnız dərslər verən şəxs deyil, eyni zamanda uşağın istedadını kəşf edən, inkişafını istiqamətləndirən və təlimin uğurunu təmin edən əsas rəhbərdir. Onun diqqəti və peşəkarlığı uşağın potensialını tam şəkildə reallaşdırmasına imkan yaradır. Bu səbəbdən müəllim strateji bir lider kimi fəaliyyət göstərir və inklüziv təhsildə istedadın inkişafı üçün mühüm rol oynayır.

İstedadlı uşaqların inklüziv sinifə adaptasiyası isə ən həssas məsələlərdən biridir, çünki onların fərdi xüsusiyyətləri, öyrənmə sürətləri və sosial-emosional tələbləri digərlərindən xeyli fərqlənir. Adaptasiya çətinlikləri vaxtında aşkar edilmədikdə uşağın təlim motivasiyası azala, özünəinamı zəifləyə və inkişaf potensialı məhdudlaşa bilər. Inklüziv təhsil bütün şagirdlərin eyni mühitdə rahat və güvənli hiss etməsini təmin etməyə yönəlsə də, istedadlı uşaqların spesifik ehtiyacları əlavə dəstək tələb edir. Adaptasiya çətinlikləri əsasən akademik və sosial-emosional sahələrdə üzə çıxır və hər biri uşağın ümumi inkişafına ciddi təsir göstərir.

Akademik çətinliklərin kökündə istedadlı uşaqların sürətli öyrənmə qabiliyyəti dayanır. Onlar mövzuları qısa müddətdə və dərinlən mənimsədikləri üçün sinifin ümumi tədris tempi onlara yavaş

görünə bilər. Nəticədə dərslər maraqla azalır, diqqət yayılır və uşaq potensialını gizlətməyə başlaya bilər. Standart sinif ritmi istedadlı uşaqlar üçün həmişə uyğun olmur; kütləvi sinifin ümumi tempinə uyğunlaşmaq onların ciddi akademik problemlərindən biridir. Bu vəziyyətdə uşaq özünü geri qalmış hiss edir və əlavə imkanlar axtarmağa meyilli olur. Uyğunsuz təlim ritmi uzunmüddətli dövrdə akademik nəticələrə mənfi təsir göstərir və uşağın təlimdən uzaqlaşmasına səbəb olur.

Sosial-emosional çətinliklər də adaptasiyaya əhəmiyyətli təsir göstərir. İstedadlı uşaqlar bəzən yaşadlarından fərqli düşüncə və davranış sərgilədikləri üçün özlərini anlaşılmamış hiss edə bilərlər. Bu, onların yeni mühitdə çətinliklərlə davranmasına, dərslər aktiv iştirakdan çəkinməsinə və sosial təşəbbüsdən uzaqlaşmasına gətirib çıxarır. Həmçinin, yüksək istedadlı uşaqlar tez-tez mükəmməlliyə can atdıqları üçün emosional gərginlik yaşayırlar. Yaşadılarla ünsiyyət problemləri onların sosial təcrid olunmasına, özünə qapanmasına və məktəb mühitinə qarşı mənfi münasibət formalaşdırmasına səbəb ola bilər. Belə adaptasiya problemləri uşağın emosional və sosial inkişafına ciddi təsir göstərir və uzunmüddətli sosial uyğunlaşma məsələlərinə gətirib çıxara bilər.

Bu problemlərin həlli üçün effektiv strategiyaların tətbiqi zəruridir və bu strategiyaların məqsədi həm uşağın akademik inkişafını, həm də sosial-emosional rifahını təmin etməkdir. *Məsləhət xidməti adaptasiya prosesinin ən mühüm dəstək vasitələrindən biridir*, çünki psixoloq uşağın emosional vəziyyətini qiymətləndirir, stres və özünəinam problemlərini aşkar edir və ona uyğun psixoloji müdaxilə planı hazırlayır. Məsləhət xidməti həmçinin uşağın özünü daha yaxşı tanımasına, güclü tərəflərini dərk etməsinə və sosial bacarıqlarını inkişaf etdirməsinə kömək edir. Psixoloji dəstək uşağın inklüziv mühitdə özünü daha güvənli hiss etməsinə təmin edir. Bununla yanaşı, mentor sistemi də istedadlı uşaqlar üçün çox vacibdir, çünki mentor uşağa həm akademik, həm də sosial istiqamətdə yol göstərən, onu dəstəkləyən bir rəhbər rolunu oynayır. Mentor uşağın potensialını tanıyır, ona uyğun fəaliyyətlər təşkil edir və onun inkişafını yaxından izləyir. Mentor sistemi istedadlı uşağın özünü tək hiss etməsinin qarşısını alır və ona güvən hissi verir.

Bu strategiyaların düzgün və davamlı şəkildə tətbiqi istedadlı uşaqların inklüziv təhsil mühitində uğurlu adaptasiyasını təmin edir. Müəllimlərin, psixoloqların və valideynlərin koordinasiyalı şəkildə fəaliyyət göstərməsi uşağın inkişaf prosesini daha səmərəli edir. Beləliklə, adaptasiya problemlərinin həlli yalnız uşaq üçün deyil, bütün təhsil sistemi üçün mühüm əhəmiyyət kəsb edir və inklüziv təhsilin keyfiyyətini artırır. İstedadlı uşaqlar üçün yaradılan bu dəstək mühiti onların həm akademik nailiyyətlərini, həm də sosial-emosional sabitliklərini gücləndirir və onların cəmiyyətdə uğurlu fərd kimi formalaşmasına geniş imkan yaradır.

Inklüziv təhsil mühitində istedadlı uşaqların uğurla öyrənməsi üçün motivasiya və dəstək mexanizmləri əsas rol oynayır. Təlim prosesində uşağın öyrənmə sürəti, diqqət səviyyəsi və yaradıcılıq bacarığı motivasiya ilə birbaşa bağlıdır. Müasir pedaqogikada motivasiya və təlim uğuru arasında olan əlaqə fundamental prinsip kimi qəbul edilir. İstedadlı uşaqlar, xüsusilə inklüziv siniflərdə, həm daxili, həm də xarici motivasiya mənbələrinə qarşı yüksək həssaslıq nümayiş etdirirlər. Onların akademik nailiyyətləri motivasiyanın səviyyəsinə görə ya artır, ya da zəifləyir. Müəllim motivasiya faktorlarını düzgün müəyyən etdikdə, uşağın istedadı daha effektiv şəkildə üzə çıxır.

Daxili motivasiya uşağın maraqla göstərməsi, yeni biliklər kəşf etməsi və yaradıcı fəaliyyətlə məşğul olmaq istəyindən irəli gəlir. Xarici motivasiya isə qiymətləndirmə, mükafatlandırma və sosial tanınma ilə bağlıdır. İstedadlı uşaqlarda daxili motivasiya daha dominant olsa da, inklüziv mühitdə onların özünü ifadə imkanları bəzən məhdudlaşa bilər. Buna görə müəllim motivasiya və təlim əlaqəsini davamlı olaraq dəstəkləməlidir. Hər bir uşağın fərdi xüsusiyyətləri nəzərə alınmalı, motivasiya metodları onun fərdi ehtiyaclarına uyğunlaşdırılmalıdır.

Inklüziv sinifdə motivasiya strategiyaları çoxşaxəli olmalıdır. Burada mükafatlandırma sistemi mühüm vasitə hesab olunur, çünki o, istedadlı uşaqların nailiyyətlərini obyektiv qiymətləndirməyə və onları təşviq etməyə imkan verir. Mükafatlandırma yalnız maddi olmamalı, mənəvi vasitələrdən

də istifadə edilməlidir. Tərif, xüsusi statusun verilməsi və layihələrdə rəhbərlik kimi qeyri-maddi mükafatlar uşaqların motivasiyasına əhəmiyyətli təsir göstərir.

Uşaqların özünüifadə imkanlarının genişləndirilməsi də motivasiyanın vacib istiqamətlərindən biridir. Onlara təqdimatlar hazırlamaq, layihələr üzərində işləmək və tədqiqat aparmaq imkanları verildikdə, özünəinamları artır və fərdi bacarıqlarını nümayiş etdirmə şansı əldə edirlər. Müəllim sinif fəaliyyətini elə təşkil etməlidir ki, hər bir uşaq iştirak edə bilsin, fikir bildirə və suallar verə bilsin. Bu cür fəallıq motivasiyanı yüksəldir və bütün şagirdlər üçün əlverişli öyrənmə mühiti yaradır. İstedadlı uşaqlar isə bu şəraitdən daha səmərəli şəkildə yararlanırlar.

İstedadlı uşaqlar üçün xüsusi dəstək proqramları onların bacarıqlarını inkişaf etdirməkdə kritik rol oynayır. Məsələn, olimpiadaya hazırlıq proqramları həm intellektual inkişaf, həm də özünəinamın güclənməsi üçün mühüm vasitədir. Bu proqramlar analitik düşüncə bacarıqlarını artırır, rəqabət mühiti yaradır və uşaqları yüksək nailiyyətlərə təşviq edir. Yaradıcılıq klubları da əlavə inkişaf məkanı təmin edir; uşaqlar burada sərbəst düşünməyi, yeni ideyalar yaratmağı və bacarıqlarını sərgiləməyi öyrənirlər. Klublar həm də sosiallaşma üçün şərait yaradır, uşaqlar oxşar maraqlara malik həmyaşıdlarla ünsiyyət quraraq daha rahat olur. Dəstək proqramları yalnız akademik nəticələri gücləndirmir, eyni zamanda uşaqların emosional rifahını da təmin edir. Bu prosesdə müəllim və psixoloq birgə fəaliyyət göstərməli, fərdi inkişaf planları hazırlamalıdır ki, proqramların effektivliyi maksimuma çatdırılsın.

Təlim mühitinin inklüziv şəkildə təşkili motivasiya və dəstək mexanizmlərinin uğurlu tətbiqi üçün əsasdır. Texnoloji vasitələr istedadlı uşaqların öyrənməsini daha interaktiv və maraqlı edir. Rəqəmsal alətlər araşdırma aparmaq, təqdimat hazırlamaq və yaradıcılıq işləri görmək üçün əlavə imkan yaradır. İnteraktiv proqramlar uşaqlara fərdi öyrənmə tempinə uyğun hərəkət etməyə şərait təmin edir. Eyni zamanda texnologiya uşaqların yeni bilik sahələrinə çıxışını təmin edir.

Psixoloji təhlükəsizlik də inklüziv təhsilin vacib komponentidir. Belə mühitdə uşaqlar öz potensiallarını sərbəst ifadə edə bilər, fikirlərini qorxmada paylaşırlar. Müəllimlər psixoloji sabitliyi təmin etməli, uşaqlar arasında qarşılıqlı hörmət mühitini gücləndirməlidirlər. Şagird yönümlü təlim mühiti motivasiya mexanizmlərini daha effektiv edir və istedadlı uşaqların öyrənmə prosesində özlərini dəyərli hiss etməsinə imkan yaradır. Nəticədə motivasiya və dəstək mexanizmləri inklüziv təhsil mühitində istedadlı uşaqların uğurlu inkişafı üçün ayrılmaz şərt kimi çıxış edir.

İstedadlı uşaqların inklüziv təhsil vasitəsilə sosial inteqrasiyası onların harmonik inkişafının əsas istiqamətlərindən biri hesab olunur. *Sosiallaşma* istedadlı uşaqların cəmiyyətlə əlaqə yaratmasını təmin edən mühüm prosesdir. Sosiallaşmanın rolu uşağın davranışlarının formalaşmasında, dəyərlər sisteminin yaranmasında və sosial bacarıqların inkişafında xüsusi əhəmiyyət kəsb edir. İstedadlı uşaqlar üçün sosiallaşma yalnız ünsiyyət bacarığı deyil, həm də emosional sabitlik deməkdir. Inklüziv mühitdə sosiallaşma daha geniş və çoxşaxəli şəkildə aparılır. Sosiallaşmanın düzgün təşkili uşağın özünü dərk etməsinə müsbət təsir göstərir. Sosial mühit uşağın identikliyinə inkişafı üçün zəruri şərait yaradır. Bu proses təkəcə məktəbdə deyil, ailədə və ictimai mühitdə də davam etdirilməlidir. İstedadlı uşaqlar bəzən sosial mühitə uyğunlaşmaqda çətinlik çəkə bilərlər. Buna görə sosiallaşmanın rolu inklüziv təhsildə daha da önəm qazanır.

İstedadlı uşaqların sosial ehtiyacları digərlərindən fərqlənə bilər. Liderlik meyli onların təbii xüsusiyyətlərindən biridir. Bu meyl uşaqda məsuliyyət hissinin erkən yaşdan inkişaf etməsinə səbəb olur. Liderlik meyli istedadlı uşağın sinifdə daha çox təşəbbüskar olmasına gətirib çıxarır. Bu xüsusiyyət zamanında düzgün istiqamətləndirilsə, sosial inteqrasiya prosesi daha rahat keçər. Eyni zamanda istedadlı uşaqlarda empatiya bacarıqları da xüsusi diqqət tələb edir. Onlar çox vaxt emosional həssas olurlar və başqalarının hisslərini dərinlən qavraya bilərlər. Empatiya bacarığının inkişafı sosial münasibətlərin güclənməsinə səbəb olur. Bu bacarıq uşağın həmyaşıdları ilə daha səmimi ünsiyyət qurmasına şərait yaradır. Sosial ehtiyacların düzgün müəyyən edilməsi istedadlı

uşağın sosial mühitə daha rahat daxil olmasını təmin edir. Müəllim bu ehtiyacları dərk edərək uyğun metodlar seçməlidir. Uşağın sosial ehtiyacları hər zaman fərdi yanaşma tələb edir.

İstedadlı uşaqların inklüziv təhsil çərçivəsində sosial inteqrasiyası onların harmonik inkişafı üçün əsas istiqamətlərdən biri hesab edilir. Sosiallaşma prosesi uşaqlara cəmiyyətlə əlaqə qurmaq və sosial bacarıqlarını inkişaf etdirmək imkanı verir. Bu proses həm davranışların formalaşmasına, həm dəyərlərin mənimsənilməsinə, həm də sosial bacarıqların inkişafına əhəmiyyətli təsir göstərir. İstedadlı uşaqlar üçün sosiallaşma yalnız ünsiyyət bacarığı deyil, eyni zamanda emosional sabillik anlamına gəlir. Inklüziv mühitdə bu proses daha geniş və çoxşaxəli şəkildə reallaşdırılır. Sosiallaşma düzgün təşkil olunduqda uşağın özünü anlama bacarığı güclənir və identikliyin formalaşması üçün əlverişli şərait yaranır. Bu proses yalnız məktəbdə deyil, ailədə və ictimai mühitdə də davam etdirilməlidir. Lakin istedadlı uşaqlar bəzən sosial mühitə uyğunlaşmaqda çətinlik çəkə bilirlər; bu səbəbdən inklüziv təhsildə sosiallaşmanın əhəmiyyəti artır.

İstedadlı uşaqların sosial ehtiyacları digər şagirdlərin ehtiyaclarından fərqlənə bilər. Liderlik meyli onların təbii xüsusiyyətlərindəndir və erkən yaşlardan məsuliyyət hissəsinin inkişafına səbəb olur. Bu meyl uşaqların sinifdə təşəbbüskar olmasına gətirib çıxarır. Liderlik bacarığı düzgün istiqamətləndirilərsə, sosial inteqrasiya daha rahat həyata keçirilir. Həmçinin, istedadlı uşaqlarda empatiya bacarıqları xüsusi diqqət tələb edir, çünki onlar emosional olaraq həssas olur və başqalarının hissələrini dərinlən qavraya bilirlər. Empatiya bacarığının inkişafı uşaqların həmyaşdaları ilə daha səmimi ünsiyyət qurmasına şərait yaradır. Sosial ehtiyacların düzgün müəyyən edilməsi istedadlı uşağın mühitə daha rahat inteqrasiya olmasına yardım edir. Müəllim bu ehtiyacları nəzərə alaraq uyğun strategiyalar seçməlidir. Uşaqların sosial ehtiyacları həmişə fərdi yanaşma tələb edir.

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СТУДЕНТТЕРДІҢ ӨЗІН-ӨЗІ РЕТТЕУ ДАҒДЫСЫН ҚАЛЫПТАСТЫРУ ЕРЕКШЕЛІКТЕРІ

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Қазіргі қоғамда білім беру кеңістігі қарқынды дамып, жаңа өзгерістерге ұшырап, студенттердің әлеуметтік ортаға бейімделу талаптары күннен күнге артып келеді. Жоғары оқу орнына түсу – жеке тұлғаның өміріндегі маңызды кезеңдердің бірі. Бұл уақыт жасөспірімдік кезеңмен тұспа-тұс келетіндіктен, олар психоэмоциялық тұрғыдан өте сезімтал, өзгерістерге толы, әлеуметтік қарым-қатынастарды қайта құру сатысынан өтеді. Жаңа ортаға бейімделу, оқу талаптарының күшеюі, жеке жауапкершіліктің артуы, өзін таныту қажеттілігі – студенттің ішкі ресурстарын көп талап етеді.

Алайда барлық студенттерге ол кезең жеңіл болмайды, көптеген қиындықтарға тап болып, қақтығыстар пайда болады. Ал ол оқу мотивациясына әсер етіп, тұлғаралық қақтығыстарының бұзылуына алып келуі мүмкін. Сондықтан студенттерге өзін-өзі реттеу дағдыларын қалыптастыру қажеттілігі туындайды. Өзін-өзі реттеу – өз эмоциялық жай-күйін түсіну, бақылау және басқара алу қабілеті және бұл олардың сәтті бейімделуі мен психологиялық денсаулығының негізгі шарты болып табылады.

А.В.Петровский, М.Г.Ярошевскийдің психология сөздігінде: өзін-өзі реттеу (латынша *re-gulare* — тәртіпке келтіру, қалыпқа салу) — әртүрлі деңгейдегі және күрделіліктегі тірі жүйелердің мақсатқа сай қызмет етуі. Психикалық өзін-өзі реттеу — осы жүйелердің белсенділігін реттеудің бір деңгейі, оны жүзеге асыратын психикалық бейнелеу құралдары мен шындықты модельдеу ерекшеліктерін, соның ішінде субъектінің рефлексиясын білдіреді.

Өзін-өзі реттеу элементтеріне мыналарды жатқыза аламыз:

1. Эмоцияларды басқару – қорқыныш, ашу-ыза, стресс т.б. сезімдерді бақылау;
2. Ойларды басқару – теріс немесе негатив ойларды тоқтатып, тиімді және жағымды ойларға көшу;
3. Мінез-құлықты басқару – жағымсыз және асығыс әрекеттерді болдырмау;
4. Мақсатқа сай әрекет ету – мақсат қоя білу және оны жүзеге асыру.

Осы элементтер нақты жағдайларға, жүйке қызметінің ерекшеліктеріне, субъектінің тұлғалық сапаларына және оның іс-әрекетті ұйымдастыру дағдыларына байланысты дара формада жүзеге асады. Оларды оқу-тәрбие және өмірлік тәжірибе барысында студент дағдысына айналдыруға болады. Студент өз эмоциясын басқаруын оқуда, жеке өмірінде немесе күрделі жағдайларда өзінде туындаған сезімдерін түсініп, оны бақылап, реттей алуы маңызды. Ол эмоцияға беріліп, асығыс шешім шығармай, саналы түрде басқарып дұрыс шешім қабылдай алуын жатқызамыз. Оны былай байқауға болады:

- Студент өз сезімдерін қобалжу, қуаныш, ашу т.б. деп эмоциясын тануы;
- Студент өзін мазасыздануда тыныштандыра алса, ашуға берілмей импульсивті әрекеттерден бас тартып эмоциясын бақылауда ұстауы;
- Студент өзінің жаман ойларын позитив ойға немесе назарын басқа жаққа бөліп эмоциясын реттей алуы;
- Студент кез келген ортада кикілжіңге түспей, пікірталаста сабырлы болып, топта жұмыс жасай алуы яғни әлеуметтік ортада өз эмоциясын басқаруы;

- Студент сессия, емтихан алдында стресс пен қобалжуды жеңе біліп, оқу барындағы эмоциясын басқаруы;

Егер ол аталған эмоцияларын басқара алса, ойланып барып әрекет ететін тұлғаға айналады.

Сонымен қатар студент өзінің керексіз, теріс немесе алаңдататын ойларды реттеп, оқу мен даму үшін пайдалы бағытқа бұра білу қабілетін былай байқай аламыз:

- Студент өз санасындағы теріс, мазасыз немесе назарын шашатын ойларды анықтап, қайдан пайда болып жатқанын байқап ойын бақылай алуы;

- Студент «Мен істей алмаймын», «Мен үлгермеймін» деген теріс ойларын тоқтатуы;

- «Мен қателесемін» → «Мен тырысып көрсем, міндетті түрде үйренемін» деген жағымды ойға қайта бағыттауы;

- Студент ойын керексіз, артық дүниеден бөліп, сабағына, емтиханға жинақтай білуі;

- Студент ойын талдап, дәлелдеп, қажетсіз стереотиптерден арылып, ақпаратты тексеріп, саналы шешім қабылдауы.

Осылай өз ойларын басқара алса – оның ойы жинақы, шешімдері саналы, оқуындағы мотивация тұрақты, стресс деңгейі төмен болады.

Келесі студенттердің өз мінез-құлқын саналы түрде бақылап, реттей алу қабілеті. Яғни белгілі бір жағдайда қалай әрекет ету керегін ойланып, эмоцияға берілмей, әлеуметтік нормаларға, өз мақсаттарына сәйкес әрекет ету.

Бұл дағды нені қамтиды:

- Студент өз әрекеттерін бақылайды, ойланбай жасайтын әрекеттерден аулақ болуы;

- Кез келген жерде қалай сөйлеу, қалай әрекет ету керегін түсінуі;

- студент қарым-қатынаста мәдениет сақтап, басқалардың да сезімін ескере алуы;

- Кикілжіңдерге түспеу және стресте де өз-өзін жоғалтпауы;

- Студент қміріндегі қажет емес әдеттерді жақсы әдеттерді қалыптастырумен алмастыру.

Студенттердің мінезді басқара алу дағдысы – бұл олардың өз әрекеттерін, әдеттерін, әлеуметтік мінез-құлқын саналы түрде реттей алуымен көрініс береді.

Оқу, тәрбие барысында осы аталған дағдыларды қалыптастыру үшін тиімді әдістердің қатарына когнитивті-мінез-құлықтық техникаларды, арт-терапия элементтерін, дене-бағдарлы практикаларды және интерактивті жұмыс түрлерін (топтық талқылаулар, рөлдік ойындар) біріктіретін кешенді тәсілдерді қолдануға болады. Студенттердің өзін-өзі реттеу бойынша практикалық дағдылары әртүрлі техникалар мен стратегияларды қамтиды Мен психология және педагогика сабақтарында екінші курс студенттерімен аталған әдіс, техникаларды қолданудамын. Қазіргі оқу үрдісі тек теориялық білім беріп қалумен ғана шектелмейді. Оларды қазіргі қоғамға бейімдеу, өздігінен дамуға және әрекет етіп, өз қиыншылықтарын жеңе алуға дайындау. Олар үшін арт-терапия элементтері, топтық талқылаулар және ойын жаттығулар өте қызықты. Барлығы оларды өмірдің түрлі жағдайларында эмоциялық реакцияларын және мінез-құлқын бақылауға үйретеді.

Мысалы, тыныс алу жаттығуларын емтихан алдында немесе қақтығыс кезінде мазасыздық деңгейін төмендетуге және эмоциялық тепе-теңдікті тез қалпына келтіруге қолдануға болады.

«Мен-хабарламаларын» пайдалану олардың өз сезімдерін айыптаусыз және агрессиясыз білдіруге мүмкіндік береді. «Сен мені ашуландырасың» дегеннің орнына «Мен... болғанда ашуланамын» деп айтуға үйренеді, бұл қарым-қатынасты анағұрлым жақсырақ етеді.

Өз ойларын талдау және балама түсіндірмелерді іздеу, мысалы, сәтсіздікті жаңа нәрсе үйренуге мүмкіндік ретінде қайта қарастырса, ойлау икемділігін арттырып, стресс деңгейін төмендетеді.

Маңызды дағдылардың бірі – жауап бермес бұрын немесе әрекет жасамас бұрын кідіріс жасап, ойланып алу. Бұл импульсивті және деструктивті реакциялардың алдын алуға көмектеседі.

Сонымен қатар, эмоцияға арналған күнделік жүргізсе. Ол эмоционалдық күйлерін бақылауға, мәселенің себебін анықтауға мүмкіндік береді, бұл өзін-өзі реттеу процесін айтарлықтай жеңілдетеді.

Сонымен, студенттердің өзін-өзі реттеу дағдыларын қалыптастыруы – олардың табысты тұлғалық және әлеуметтік дамуының негізгі шарты. Мұндай дағдылардың дамуы психологиялық тұрақтылықты күшейтіп, эмоциялық интеллектті жақсартады және тұлғааралық қарым-қатынастың сапасын арттырады. Саналылық техникаларын, эмоциялық реакцияларды бақылау әдістерін және ішкі және сыртқы стресс факторларымен тиімді күресуге, мазасыздықты төмендетуге көмектеседі.

Студенттердің өзін-өзі реттеу дағдысын қалыптастыру – мотивациялық, когнитивтік, эмоциялық және әлеуметтік компоненттердің өзара байланысына негізделген күрделі психологиялық процесс. Бұл дағдылардың дамуы студенттің академиялық табыстылығын, кәсіби қалыптасуын және психологиялық тұрақтылығын қамтамасыз ететін негізгі факторлардың бірі. Осылайша, студенттердің өзін-өзі реттеуін дамыту бойынша жүйелі жұмыс олардың үйлесімді қалыптасуы мен қазіргі қоғамда сәтті бейімделуі үшін маңызды рөл атқарады.

THE MAIN ROLES OF PERCEPTION IN COGNITIVE PROCESSES

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Keywords: perception, cognition, roles of perception, information

Perception is one of the main psychological processes in human understanding of the world around us. In psychology, perception is explained as the transformation of information received through the sensory organs into whole, meaningful images in the brain. This process is not just the accumulation of sensations, but a complex cognitive activity that is closely related to a person's previous knowledge, experience, emotional state and attention. Perception is a fundamental factor that determines human behavior, decision-making, orientation in everyday life and communication with the environment.

The study of perception is of great importance in psychology, because how a person sees the world, how he recognizes objects and how he analyzes events shapes his way of thinking. Without perception, other cognitive processes of human activity - thinking, memory, attention - cannot be fully implemented. Therefore, perception is considered the initial stage of cognition in psychological science and is the main subject of many classical and modern studies.

Perception is not just a passive repetition of external stimuli, but a continuous psychological activity in which sensations are determined, combined and modified by previous experience. Each perceptual process includes not only the current sensation, but also traces of previous impressions, and as a result of apperception, they are transformed into a single idea. Therefore, perception is an active processing process that depends on the influence of both external stimuli and the internal state of consciousness. Perception is one of the most basic functions of the human psyche, and its role in psychology is multifaceted. The role of perception in psychology is considered in the following aspects:

1. As an organization of mental activity

Perception plays a central role in the process of a person receiving, organizing and interpreting information from the environment. A person collects information only through the senses, but perception transforms this information into conscious experience. This is important both in decision-making and in everyday life.

2. As an adaptive process

Perception is a multifaceted cognitive function that allows a person to analyze and organize sensory information received from the environment. It is not simply the recording of stimuli, but an active construction process in which the perceiver creates complete representations that allow him to understand objects, events, and relationships. Perception depends heavily on attention, memory, prior knowledge, and expectations; that is, what we perceive is never a simple copy of the external world. Rather, perception is an adaptive psychological mechanism that allows humans to extract meaning from complex and ambiguous sensory information.

3. Perception as information processing

Perception is one of the main psychological processes in human understanding of the world around us. In psychology, perception is explained as the transformation of information received through the sensory organs into whole, meaningful images in the brain. This process is

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The study of perception is of great importance in psychology, because how a person sees the world, how he recognizes objects and how he analyzes events shapes his way of thinking. Without perception, other cognitive processes of human activity - thinking, memory, attention - cannot be fully implemented. Therefore, perception is considered the initial stage of cognition in psychological science and is the main subject of many classical and modern studies.

Perception plays a central role in the process of perception, as it ensures that a person functions properly by transforming sensory information into logical and meaningful experiences. Perception is a central mechanism of human psychology and plays a vital role in interaction with the environment. Visual, auditory, gustatory, and tactile perceptions are complementary systems for a person to receive, interpret, and respond appropriately to information. Each type of perception is not only about receiving sensory information, but also integrating, analyzing, and transforming it into a meaningful experience in the brain. Examples of foreign literature show that perception is related to both physiological and cognitive processes. Scientists such as Arnheim and Helmholtz emphasized that visual and auditory perception is an active and constructive process, while Shepherd and Hummel emphasized that taste, smell, and tactile perceptions affect human behavior, memory, and emotions. These perceptions are applied in various areas of everyday life: traffic safety, coordination of sports and physical activities, communication in social relationships, nutrition, and health protection. Thus, perceptual psychology is a fundamental field that serves to make human life more efficient, safe, and meaningful.

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Economic Sciences

ЖАСАНДЫ ИНТЕЛЛЕКТ- ЭКОНОМИКАНЫ ЖАҢҒЫРТУ ҚҰРАЛЫ

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Жасанды интеллект - бұл компьютерлік жүйелердің дәстүрлі түрде адамдарға тән интеллектуалды және шығармашылық функцияларды орындау қабілеті. Бұл анықтама, ЖИ термині сияқты, алғаш рет 1956 жылы Дартмут колледжіндегі жазғы семинарда айтылды, оны төрт американдық ғалым ұйымдастырды: Джон Маккарти, Марвин Ли Минский, Натаниэль Рочестер және Клод Шеннон. Содан бері бұл түсінік соншалықты танымал болды, ол туралы естімеген адамды сирек кездестіруге болады. Бүгінгі таңда жасанды интеллект технологиялары смартфондарда, ақылды үй жүйелерінде, медицинада, білім беруде және өнеркәсіпте қолданылады. Алайда, бұл әзірлемелер адамды толықтай алмастыра алмайды: ЖИ адам миы жұмыс істей алатын көп тапсырмалылыққа ие емес [1].

50 жылдан астам уақыт бұрын кибернетиканың негізін қалаушылар Винер және фон Нейман компьютердің есептеу мүмкіндіктерін адам миының когнитивтік қабілеттерімен байланыстыру, интеграциялау мәселесін тұжырымдады. Бұл идея когнитивтік технологиялардың негізін қалады. Когнитивтік технологиялар субъектілердің мақсаттарына жетудің әртүрлі тәсілдері мен алгоритмдерін білдіреді. Олар ақпаратты өңдеу, таным, коммуникация процестері туралы деректерге, нейроғылым жетістіктеріне, өзін-өзі ұйымдастыру және өзін-өзі реттеу теориясына, ақпараттық технологияларға, сананың жеке элементтерін математикалық модельдеуге және басқа да ғылыми бағыттарға сүйенеді.

Адам мен машина арасындағы интерфейс: Технологиялармен анағұрлым табиғи түрде әрекеттесуге мүмкіндік беретін сезімтал құрылғылар мен нейроинтерфейстер.

«Интерфейс» сөзі ағылшын тілінен шыққан және сөзбе-сөз өзара әрекеттесу, байланыс дегенді білдіреді. Кең мағынада бұл ұғым пайдаланушыға электрондық құрылғымен әрекеттесуге, одан ақпарат алуға және қажетті деректерді енгізуге мүмкіндік беретін кез келген визуалды-бағдарламалық ортаны білдіреді. Дәстүрлі ақпараттық жүйелер көбінесе мәзірлер, түймелер және пішіндері бар статикалық интерфейсдерге сенеді. Бұл интерфейсдер негізгі мақсатқа қызмет еткенімен, олар, әсіресе жүйенің қыр-сырын білмейтін пайдаланушылар үшін қолайсыз және тиімсіз болуы мүмкін. Интеллектуалды интерфейсдер бұл өзара әрекеттесуді түбегейлі өзгертуге арналған. Табиғи тілді өңдеу (NLP) және машиналық оқыту сияқты жасанды интеллект әдістерін қолдана отырып, бұл интерфейсдер пайдаланушының ниетін түсінеді және жеке қажеттіліктерге бейімделеді [2].

Пайдаланушылардың инвестициялық портфелі туралы сұрақтарына күрделі мәзірлер мен есептерді шарлауды талап етудің орнына, табиғи тілде жауап бере алатын қаржылық ақпараттық жүйені елестетіп көріңіз. NLP интерфейске пайдаланушының сұрауын түсінуге және күрделі деректерге қол жеткізуді жеңілдетіп, тиісті ақпаратты алуға мүмкіндік береді. Машиналық оқыту алгоритмдері пайдаланушы тәжірибесін одан әрі жақсартады.

Пайдаланушылардың мінез-құлық үлгілері мен іздеу сұрауларын уақыт өте келе талдай отырып, бұл интерфейстер ақпаратты ұсынуды жекелендіріп, пайдаланушылардың қажеттіліктерін болжай алады.

Өзіңіздің қалаған тақырыптарыңызды зерттейтін және жаңалықтар лентасын тиісінше бейімдейтін, сіздің қызығушылықтарыңызға сәйкес келетін мақалаларға басымдық беретін жаңалықтар платформасын елестетіп көріңіз. Мұндай жекелендіру пайдаланушылардың уақытын үнемдеп қана қоймай, ақпараттық жүйеге жалпы қанағаттануды арттырады. Сонымен қатар, интеллектуалды интерфейстер контекстік хабардарлықты пайдалана алады. Сіздің орналасқан жеріңізге, ағымдағы уақытқа және өткен гастрономиялық қалауларыңызға байланысты мейрамханаларды ұсынатын виртуалды көмекшіні елестетіп көріңіз. Пайдаланушымен өзара әрекеттесу контекстін ескере отырып, бұл интерфейстер өте өзекті және уақытылы ақпаратты береді. Интеллектуалды интерфейстер мәтіндік өзара әрекеттесуден асып түседі. Дауыс тану технологиялары пайдаланушыларға ақпараттық жүйелермен табиғи сөйлеу арқылы әрекеттесуге мүмкіндік береді, бұл анағұрлым интуитивті интерфейсін және қолсыз пайдалану мүмкіндігін ұсынады. Күрделі деректер базасын басқару жүйесіндегі белгілі бір есептерге немесе кестелерге қол жеткізу үшін дауыстық командаларды пайдаланатын бос емес кәсіби маманды елестетіп көріңіз. Сонымен қатар, мультимодальды интерфейстер дауысты түртумен, ым-ишараларды танумен және тіпті бет әлпетімен біріктіріп, анағұрлым табиғи және қызықты өзара әрекеттесу парадигмасын жасайды. Бейне дәрістер кезінде студенттің бет әлпетіне қарап білім беру контентін жекелендіретін, түсініксіз аймақтарды анықтайтын және қосымша материалдарды ұсынатын оқытуды басқару жүйесін елестетіп көріңіз.

Интеллектуалды интерфейстерді әзірлеу және енгізу адам мен ақпараттық жүйе арасындағы өзара әрекеттесудегі маңызды өзгерісті білдіреді. Бұл интерфейстер адам интеллектін алмастыру үшін емес, керісінше, оны толықтыру үшін жасалған, пайдаланушыларға ақпаратқа анағұрлым тиімді қол жеткізу, талдау және пайдалану үшін қуатты құралдар береді. Жасанды интеллект дамуын жалғастырған сайын, адамдар мен интеллектуалды интерфейстер арасындағы ынтымақтастық қалыпты жағдайға айналады. Адам мақсаттар мен контексті қамтамасыз етеді, ал интеллектуалды интерфейс өзінің кең білімі мен есептеу қуатын ақпарат беру және тапсырмаларды орындау үшін пайдаланады. Бұл бірлескен тәсіл, пайдаланушылардың мінез-құлқына және жаңа ақпараттық ландшафттарға бейімделетін үздіксіз оқыту алгоритмдерімен үйлесімде, адам мен ақпараттық жүйе арасындағы өзара әрекеттесудің үздіксіз, интуитивті болашағын уәде етеді және пайдаланушыларға барған сайын күрделене түскен әлемде негізделген шешімдер қабылдауға мүмкіндік береді.

Интеллектуалды интерфейстердің әсері пайдаланушы тәжірибесін жақсартудан асып түседі. Бұл интерфейстер әртүрлі секторларда төңкеріс жасай алады. Денсаулық сақтау саласында, пациенттердің медициналық сұрақтарына жауап бере алатын, кездесулер тағайындай алатын және тіпті медициналық қызметкерлердің жүктемесін азайта отырып, базалық сұрыптау қызметтерін көрсете алатын жасанды интеллект негізіндегі чат-боттарды елестетіп көріңіз. Білім беру саласында интеллектуалды интерфейстер оқу материалдарын жекелендіріп, оқыту стильдерін оқушылардың жеке қажеттіліктеріне бейімдей алады, бұл тереңірек түсінуге және оқу нәтижелерін жақсартуға ықпал етеді.

Тұрақты және түсінікті модельдер: Критикалық маңызды салаларда қолдануға ықпал ететін, оңай түсіндірілетін және басқарылатын жасанды интеллект жүйелерін құру.

Ашық қол жетімділіктегі алғашқы Негізгі Тіл Моделі, жасанды нейрондық желілер (ЖЖЖ) архитектурасының мүлдем жаңа класы ретінде, 2022 жылдың қараша айында ChatGPT пайда болғалы бері, НТМ-нің заманауи адамның өмірінің барлық саласына әсер еткен түрлі цифрлық шешімдерде қолданылуы экспоненциалды түрде өсті. 2023 жылдың

соңына қарай Негізгі Тіл Модельдері жасанды интеллект технологиялары саласындағы негізгі бағытқа айналды. НТМ (Негізгі Тіл Модельдері) модельдерінің санының өсуіне, мультимодальды деректермен жұмыс істей алатын нұсқалардың пайда болуына байланысты, оларды пайдалана отырып гибриді интеллектуалды жүйелерді құру барған сайын тиімдірек болып көрінеді. "Қара жәшікпен" және жасанды интеллект жүйелеріндегі бір жақтылықтың әсерімен байланысты мәселелерді түсіне отырып, әзірлеушілер мен деректерді өңдеу және талдау мамандары неғұрлым ашық және әділ Негізгі Тіл Модельдерін құру үшін жұмыс істей алады [3].

Түсініктілік- бұл жай ғана техникалық сипаттама емес; ол адамгершілік құндылықтар мен қоғамның қажеттіліктеріне сәйкес келетін жауапты және сенімді ЖИ қосымшаларын құру үшін fundamental мәніне ие. Кестеде ЖИ шешімдерінің салдары жеке адамдар мен қауымдастықтарға айтарлықтай әсер етуі мүмкін денсаулық сақтау, қаржы және юриспруденция сияқты критикалық маңызды секторлардағы осы аспектілердің маңыздылығы атап көрсетілген. Түсініктілік принциптерін енгізе отырып, біз негізгі Тіл Модельдерінің әлеуетін аша аламыз, сонымен бірге ЖИ жүйелеріне әділдік, есептілік және сенімділікті сақтай аламыз.

Кесте 1. Тіл Модельдерінің маңызды аспектілері

Міндеттер	Сипаттама	Қолданбалы міндеттердегі түсініктіліктің маңыздылығы
Қара жәшіктің дилеммасы	"Негізгі тілдік модельдер "қара жәшіктер" сияқты жұмыс істейді, бұл олардың ішкі процестерін түсінуді қиындатады."	Түсініктеме Базалық Тіл Модельдерінің шешім қабылдау процесі туралы түсінік береді.
	Түсіндірудің болмауы сенімсіздікке әкеліп, маңызды секторларда жасанды интеллект жүйелерінің енгізілуіне кедергі келтіруі мүмкін.	Денсаулық сақтау, қаржы және заңгерлік салаларында, есептілік шешуші мәнге ие болған жерде, түсініктілік өте маңызды.
	Түсіндірмелі жасанды интеллект (ТЖИ) жүйелері пайдаланушылардың сенімін арттырады және жасанды интеллекттің кеңінен енгізілуіне ықпал етеді.	Базалық тілдік модельдердің шешім қабылдайтынын түсіну, ЖИ негізіндегі шешімдерді қабылдау мен енгізуге ықпал етеді.
Көзқарастармен күресу	Искусственный интеллект моделдері, соның ішінде негізгі тілдік моделдер, оқыту деректеріндегі бар алдын ала көзқарасты байқаусызда мәңгілік ете алады.	Түсіндірмелі жасанды интеллект әділеттілік пен нәтижелердің теңдігін қамтамасыз ете отырып, қате шешімдерді анықтауға көмектеседі
	Жасанды интеллект жүйелері белгілі бір адамдар тобын және жекелеген адамдарды қолайсыз жағдайға қалдырып, кемсітушілік нәтижелерге әкелуі мүмкін.	Әзірлеушілер, алдын ала көзқарастарды анықтай отырып, түзету шараларын қолдана алады, бұл жасанды интеллект қосымшаларын этикалық нормаларға сәйкес келтіреді.
	Жасанды интеллект саласындағы әділдікті қамтамасыз ету - бұл түсініктілік пен есептілікке ерекше назар аударуды талап ететін қоғамдық міндеттеме	Түсінікті жасанды интеллект қоғамның барлық топтарына пайда әкелуін қамтамасыз етеді және кепілдік береді
Дерек көзі: [4]		

Түсініктілік - бұл Негізгі Тіл Модельдерінің маңызды аспектісі, ол бізге олардың шешімдерінің негізінде жатқан логиканы түсінуге мүмкіндік береді. Негізгі Тіл Модельдерінде түсініктілікке қол жеткізу үшін олардың ішкі жұмысы туралы қажетті ақпаратты беретін бірнеше әдіс жасалды. Осы әдістердің кейбіреулері кестеде қарастырылған.

Кесте 2. Тіл Модельдерінің маңызды аспектілері

Техника	Сипаттама	Артықшылықтары
Назар аудару механизмдері	Өңдеу кезінде белгілі бір сөздерге немесе жиі кездесетін сөйлемдерге назар аударуға мүмкіндік береді. Назар аударудың салмақ коэффициенттерін визуализациялау модельдің айқындығын арттырады.	Кіріс деректердің маңызды бөліктерін анықтайды, модельдің шешім қабылдау жолын түсінуге көмектеседі.
Зондтау міндеттері	Модельдің лингвистикалық қасиеттерін түсінуін тексереді, оның білімі туралы түсінік көрсетеді.	Модельдің тілді түсінуге негізделіп шешім қабылдау процесін түсіндіруге көмектеседі.
Қабаттық талдау	Иерархиялық өңдеуді түсіну үшін әр қабаттың шығыс деректерін талдайды.	Әр деңгейде шешімдерді түсіндіруге көмектесіп, кіріс деректерінің қадамдық түрлендіруін көрсетеді.
Ережелерге негізделген түсіндірмелер.	Модельдің мінез-құлқын түсіндіретін интерпретацияланатын ережелер жасайды.	Модельдің болжамдары үшін оңай оқылатын түсіндірмелер береді, түсіну мен сенімге ықпал етеді.
Бұзылуларға негізделген әдістер.	Модельдің болжамдарындағы өзгерістерді бақылау үшін кіріс деректерін сәл өзгертеді.	Модельдің нақты кіріс деректеріне қаншалықты тәуелді екенін түсіну арқылы маңызды белгілерді анықтайды.
Контрфактілік түсіндірмелер	Болжамдардағы өзгерістерді бақылау үшін балама кіріс деректерін береді.	Модельдің шешім қабылдау шекаралары және кіріс деректерінің өзгеруіне сезімталдығы туралы түсінік береді.
Дерек көзі: [5]		

Негізгі тіл модельдерінің түсініктілік әдістері тілдік ЖИ модельдері қабылдайтын шешімдерді түсіну және түсіндіру үшін заманауи құралдарды ұсынады. Әрбір әдістің өзіндік артықшылықтары бар және басқаларын толықтырады, бұл әзірлеушілер мен зерттеушілерге негізгі тіл модельдері туралы тереңірек түсінік алуға және жасанды интеллектпен басқарылатын жүйелерге ашықтық пен сенімділікті арттыруға мүмкіндік береді. Оларды толығырақ қарастырайық. Негізгі тіл модельдеріндегі назар аудару механизмдері оларға өңдеу кезінде белгілі бір сөздерге немесе сөйлемнің бөліктеріне назар аударуға мүмкіндік береді. Назар аударудың салмақты коэффициенттерін визуализациялау арқылы біз модельдің болжам жасау үшін енгізу деректерінің қай бөліктерін ең маңызды деп

санайтынын түсіне аламыз. Бұл әдіс модельдің ашықтығын арттырады және оның шығыс деректерінің негізінде жатқан себептерді анықтауға көмектеседі.

Бірнеше негізгі аспектіні бөліп көрсетуге болады:

1. Деректерді білімге түрлендіру: Жасанды интеллект саласындағы зерттеулер AI-дің үлкен көлемді деректерді тиімді өңдеп, талдай алатынын, олардан құнды инсайттар алатынын көрсетті. Бұл әртүрлі салалардағы анағұрлым негізделген шешімдерге әкеледі.

2. Әр түрлі салалардағы инновациялар: Жасанды интеллект медицинада, қаржыда, білім беруде, өндірісте және басқа салаларда қолданылады, бұл инновацияларды енгізуге және процестердің тиімділігін арттыруға ықпал етеді.

3. Этика және қауіпсіздік: Жасанды интеллект мүмкіндіктерінің өсуіне параллель түрде этика, деректерді қорғау және қауіпсіздікке байланысты мәселелердің маңыздылығы артады. AI-ді жауапкершілікпен пайдалану зерттеушілер тарапынан да, мемлекеттік органдар тарапынан да назар аударуды талап ететін негізгі аспектіге айналады.

4. Зерттеулердің болашағы: Өзекті зерттеу бағыттары жетілдірілген алгоритмдерді әзірлеуді, мұғалімсіз оқытуды, адам мен машинаның өзара әрекеттесуін жақсартуды және AI-дің түсініктілігімен байланысты міндеттерді шешуді қамтиды. Бұл аспектілер технологиялардың одан әрі дамуын және олардың күнделікті өмірге енгізілуін анықтайды.

5. Пәнаралық тәсіл: Жасанды интеллект саласындағы жетістік көбінесе әр түрлі салалардағы мамандардың - бағдарламалаудан бастап социологияға дейін ынтымақтастығына байланысты. Бұл зерттеулердегі пәнаралық тәсілдің қажеттілігін көрсетеді.

Осылайша, жасанды интеллект - бұл өмір сапасын және әр түрлі процестердің тиімділігін айтарлықтай жақсартатын қуатты құрал, алайда оның дамуы этикалық және әлеуметтік аспектілерге назар аударумен

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Организационные конфликты: теоретические подходы, функции и классификация

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Аннотация

В статье рассматриваются теоретические основы изучения организационных конфликтов. Уточняется содержание понятия «организационный конфликт», выделяются его ключевые признаки и отличия от других видов социальных конфликтов. Анализируются основные теоретические подходы к конфликту в менеджменте и конфликтологии: традиционный, школа человеческих отношений, интеракционистский и современные интегративные подходы. Особое внимание уделяется классификационным признакам организационных конфликтов: по уровню участников, по отношению к организационной структуре, по предмету и причинам, по форме протекания и по последствиям. Показано, что конфликты выполняют как конструктивные (информационная, диагностическая, интегративная, инновационная, развивающая), так и деструктивные функции в организации. Обосновывается необходимость не столько устранения конфликтов, сколько их управляемого использования в интересах организации. Статья может служить теоретической базой для разработки первой главы магистерской диссертации, посвящённой проблематике конфликтов в современных организациях.

Ключевые слова: конфликт, организационный конфликт, теоретические подходы, классификация конфликтов, функции конфликтов, управление конфликтами, организация

1. Введение

Конфликт как социальное явление сопровождает человеческое общество на всех этапах его развития. Любое взаимодействие людей, связанное с распределением ресурсов, власти, статуса и ответственности, неизбежно порождает противоречия, которые в определённых условиях переходят в фазу открытого противостояния [1; 3]. Современные организации представляют собой сложные социально-экономические системы, в которых переплетаются интересы собственников, менеджеров, работников, клиентов, профессиональных сообществ и государства. В такой среде конфликты становятся не исключением, а нормой функционирования [2; 8].

В управленческой практике долгое время доминировал взгляд на конфликт как на «поломку» организационного механизма, как на фактор, который необходимо максимально быстро устранить. Предполагалось, что «здоровая» организация — это бесконфликтная организация, где сотрудники разделяют цели руководства и действуют согласованно. Однако исследования второй половины XX века показали, что полное отсутствие конфликтов ведёт не к высокой эффективности, а к застою, конформизму и снижению инновационной активности [3; 4].

Развитие рыночных отношений, цифровизация, переход к гибким форматам занятости, удалённая работа и межкультурные команды усиливают сложность социальной среды организации. На этом фоне растёт значение умения руководителей и HR-служб не только

предупреждать деструктивные конфликты, но и использовать конструктивный потенциал неизбежных разногласий [5; 10].

Цель данной статьи – систематизировать теоретические взгляды на организационный конфликт, раскрыть его сущностные характеристики, классификацию и функции. Для достижения цели решаются следующие задачи:

- проанализировать понятие «организационный конфликт» и его ключевые признаки;
- рассмотреть основные теоретические подходы к конфликту в менеджменте и конфликтологии;
- представить наиболее распространённые классификации организационных конфликтов;
- охарактеризовать конструктивные и деструктивные функции конфликтов в организации;
- обозначить общие направления управленческого воздействия на конфликты.

Методологическую основу исследования составляют системный и деятельностный подходы, а также положения современной конфликтологии и организационного поведения. В работе использованы методы теоретического анализа и синтеза, сравнительно-сопоставительный анализ концепций отечественных и зарубежных авторов в области конфликтологии, социологии труда и менеджмента [1–7; 9–11]

1. Понятие организационного конфликта

В конфликтологической литературе существует множество определений конфликта. Один из классических подходов исходит из того, что конфликт – это «столкновение противоположно направленных тенденций в сознании отдельного человека, в межличностном взаимодействии или в отношениях групп» [1]. М. Дойч определяет конфликт как ситуацию, в которой действия одной стороны препятствуют или блокируют действия другой стороны [3]. В психологическом плане конфликт всегда связан с переживанием напряжения, чувства несправедливости и угрозы значимым интересам [2].

Применительно к организациям конфликт трактуется более узко. А. Я. Анцупов и А. И. Шипилов рассматривают организационный конфликт как высшую стадию развития противоречий между субъектами совместной деятельности, проявляющуюся в форме противоборства и сопровождающуюся негативными переживаниями участников [1]. Н. В. Гришина подчёркивает, что организационный конфликт возникает в рамках формально структурированной системы и опосредован ролевыми ожиданиями, организационными нормами и регламентами [2].

Л. Г. Брылева, анализируя социальную природу организационных конфликтов, обращает внимание на то, что такие конфликты обусловлены специфическим устройством структурных подразделений, проблемным взаимодействием между ними и действиями персонала, решающего производственные задачи в ущерб интересам отдельной личности [10]. В ряде исследований проводится различие между трудовыми (социально-трудовыми) и организационными конфликтами: первые непосредственно связаны с условиями и оплатой труда, вторые – с распределением полномочий, ответственности, статуса, информацией и управленческими решениями [9; 10].

Обобщая различные подходы, под организационным конфликтом можно понимать процесс развития и открытого проявления противоречий между членами организации (или между ними и организацией в целом), связанных с распределением ресурсов, статусов, полномочий и ценностей, сопровождающийся эмоциональной напряжённостью и противоборством сторон и оказывающий влияние на результаты деятельности организации. Ключевыми признаками организационного конфликта выступают:

- наличие как минимум двух сторон, включённых во взаимодействие (индивиды, группы, подразделения, уровни иерархии);
- наличие воспринимаемого противоречия в целях, интересах, ценностях, нормах или средствах их достижения;

- переход от латентного состояния разногласий к открытым действиям (споры, претензии, блокирование решений, обращение к третьей стороне и т.п.);
- эмоциональная вовлечённость участников, переживание напряжения, неудовлетворённости, несправедливости;
- измеримое влияние на результаты деятельности организации (производительность, качество, издержки, текучесть персонала, лояльность и др.) [1; 2; 8].

Причины организационных конфликтов многоплановы. К числу наиболее типичных относятся:

- ограниченность ресурсов (финансовых, материальных, временных, кадровых);
- различия в целях и приоритетах подразделений;
- несовместимость ценностей и профессиональных стандартов;
- неэффективные коммуникации, искажение информации;
- неопределённость или пересечение ролей и полномочий;
- восприятие решений руководства как несправедливых;
- культурные и личностные различия между сотрудниками [2; 4; 8].

На практике редко можно выделить одну «чистую» причину; чаще конфликт имеет комплексную природу, сочетая организационно-структурные и личностно-психологические факторы. Важной задачей анализа организационных конфликтов является их диагностика с учётом контекста: стадии жизненного цикла организации, особенностей корпоративной культуры, модели лидерства и управленческих практик [5; 10].

2. Теоретические подходы к изучению конфликтов

Эволюция взглядов на конфликт в менеджменте и конфликтологии условно проходит через несколько подходов, отражающих постепенный отход от представления о конфликте как исключительно негативном явлении.

2.1. Традиционный подход

Традиционный (классический) подход, сформировавшийся на ранних этапах развития научного управления, исходил из того, что конфликт — это вредное отклонение от нормы. Хорошей считалась бесконфликтная организация, где работники дисциплинированно выполняют предписанные функции. Конфликт интерпретировался как результат неправильной организации труда, неэффективного контроля или нежелания работников подчиняться установленным правилам [4; 7].

Соответственно, основными способами работы с конфликтами в традиционном подходе выступали их предотвращение, подавление и жёсткое дисциплинарное воздействие. Считалось, что чем быстрее конфликт «заглушён», тем лучше для организации. Такой взгляд был логичен для иерархически жёстких структур, ориентированных на стандартизированные операции и минимум инициативы снизу. Однако по мере усложнения организаций и усиления роли человеческого фактора ограниченность традиционного подхода стала очевидной [4; 6].

2.2. Подход человеческих отношений

Школа человеческих отношений сместила фокус с чисто формальных процедур на социально-психологические аспекты производственного поведения. В рамках этого подхода конфликты признаются неизбежными, но рассматриваются преимущественно как результат неудовлетворённых потребностей, дефицита внимания и признания, плохих коммуникаций и слабой вовлечённости работников в принятие решений [4].

Основной акцент делается на улучшении психологического климата, развитии неформальных групп, создании условий для открытого обсуждения проблем. Задача управления — не столько силой подавлять конфликт, сколько снимать напряжение путём диалога, участия сотрудников в обсуждении решений, использования групповых форм работы и систем мотивации, учитывающих социальные потребности [2; 4]. Тем самым

конфликт перестаёт восприниматься исключительно как «поломка», но ещё не рассматривается как источник развития.

2.3. Интеракционистский подход

Интеракционистский подход, сформулированный в рамках теории организационного поведения (S. Robbins, T. Judge и др.), утверждает, что определённый уровень конфликта не только неизбежен, но и желателен для эффективной работы организации [4; 7]. Полное отсутствие конфликтов ведёт к застою, формализму и «групповому мышлению». Напротив, управляемые конфликты стимулируют критическое обсуждение, выработку альтернатив, инициирование инноваций.

С позиций интеракционизма конфликты делятся на функциональные (конструктивные) и дисфункциональные (разрушительные). Функциональные конфликты способствуют прояснению целей, улучшению качества решений, адаптации к изменениям, тогда как дисфункциональные ведут к дезорганизации, росту напряжённости и снижению эффективности [4; 5].

В рамках этого подхода важным становится не само наличие или отсутствие конфликта, а его интенсивность и направленность. Менеджер должен поддерживать в организации такой уровень конструктивного конфликта, который стимулирует развитие, но не разрушает сотрудничество. Отсюда вытекает интерес к стилям управления конфликтами, детально разработанным, например, М. А. Рахимом (интегрирующий, уклоняющийся, доминирующий, приспособляющийся, компромиссный стили) [5].

2.4. Современные интегративные подходы

Современные исследования стремятся интегрировать структурные, процессуальные и психологические аспекты конфликта. Конфликт рассматривается как многостадийный процесс, включающий: возникновение объективного противоречия, его осознание сторонами, формирование конфликтной установки, эскалацию, попытки регулирования и возможное разрешение [1; 2; 10].

Особое внимание уделяется организационному контексту конфликта: типу организационной культуры, модели лидерства, системе мотивации, роли HR-подразделений и внутренних регламентов. Например, Л. Г. Брылева, анализируя управление организационными конфликтами, подчёркивает необходимость моделирования конфликтных процессов с учётом социальных ролей участников, формальных и неформальных норм, а также влияния внешней среды [10]. Важным считается и то, что организации по-разному «переваривают» конфликты в зависимости от стадии жизненного цикла: на этапах роста и изменений они неизбежно учащаются, и от зрелости управленческих практик зависит, будут ли они источником развития или дезорганизации [8; 10].

Таким образом, эволюция подходов отражает переход от представления о конфликте как об однозначно негативном отклонении к пониманию его как нормального и потенциально полезного элемента организационной жизни при условии эффективного управления.

3. Классификация организационных конфликтов

Многообразие проявлений конфликтов в организациях требует их систематизации. В литературе предлагается большое количество классификаций, основанных на различных критериях [1; 2; 6; 9]. Ниже представлены наиболее значимые из них.

3.1. По уровню участников

Один из базовых критериев – социальный уровень, на котором разворачивается конфликт [2; 6]:

– внутриличностный конфликт – противоречие внутри самого работника (конфликт ролей, ценностей, мотивов, ожиданий). Например, сотрудник испытывает внутренний конфликт между требованием руководства «жёстко продавать» и собственными этическими нормами;

- межличностный конфликт – столкновение двух (или нескольких) сотрудников по поводу целей, методов работы, распределения ресурсов, оценки вклада и т.п.;
- конфликт «личность – группа» – ситуация, когда сотрудник не разделяет нормы и ценности группы, либо группа отвергает его поведение (например, новый руководитель пытается изменить сложившиеся практики, встречая сопротивление коллектива);
- межгрупповой конфликт – противостояние между подразделениями, сменами, профессиональными или неформальными группами (классический пример – конфликт между отделом продаж и производством).

На практике именно межгрупповые конфликты нередко оказываются наиболее острыми, поскольку в них сталкиваются интересы подразделений, имеющих различную функциональную логику и систему показателей эффективности [4; 9].

3.2. По отношению к организационной структуре

По отношению к иерархии различают вертикальные и горизонтальные конфликты [1; 6]:

- вертикальные конфликты – конфликты между уровнями управления (руководитель – подчинённый, топ-менеджмент – средний менеджмент, собственники – наёмный менеджмент). Они часто связаны с проблемами стиля лидерства, распределения полномочий, справедливости оценивания и вознаграждения;
- горизонтальные конфликты – конфликты между сотрудниками или подразделениями, находящимися на одном уровне иерархии (между руководителями отделов, между коллегами одного ранга). Здесь чаще всего проявляются рассогласование целей, конкуренция за ресурсы и статус, профессиональные различия.

3.3. По предмету и причинам

С точки зрения предмета конфликта (того, вокруг чего возникает противоречие) выделяют:

- ресурсные конфликты – борьба за ограниченные материальные, финансовые, кадровые ресурсы, рабочее время;
- конфликты целей – несовпадение целевых установок подразделений или сотрудников (например, отдел продаж ориентирован на объём реализации, а производство – на минимизацию затрат);
- конфликты ценностей – столкновение различных систем убеждений, профессиональных и личных ценностей, представлений о справедливости и допустимых способах поведения;
- конфликты норм и ролей – неясность, пересечение или противоречивость ролевых ожиданий по отношению к сотруднику;
- конфликты взаимоотношений – обусловленные личной несовместимостью, нарушением норм уважительного общения, наличием устойчивых негативных установок [2; 9].

По причинам возникновения выделяют структурные, информационные, ролевые, мотивационные и личностные конфликты. Структурные обусловлены особенностями организационного устройства и распределением полномочий, информационные – дефицитом или искажением информации, ролевые – противоречивыми требованиями к сотруднику, мотивационные – восприятием системы поощрений как несправедливой [1; 2; 8].

3.4. По форме протекания и длительности

По форме проявления конфликты делятся на открытые и скрытые (латентные). Открытые конфликты характеризуются явными действиями сторон: выражением несогласия, предъявлением претензий, официальными жалобами, созданием коалиций. Скрытые конфликты проявляются в пассивном сопротивлении, саботаже, снижении инициативы, распространении слухов [1; 2]. Для организации скрытые конфликты нередко более опасны, поскольку долгое время остаются вне поля зрения менеджмента.

По длительности различают острые краткосрочные конфликты и затяжные, хронические, перерастающие в устойчивую враждебность между сторонами. Острый конфликт может

быть относительно быстро разрешён грамотным вмешательством, тогда как хронический конфликт часто требует глубокой переработки организационных практик и культуры [6; 10].

3.5. По последствиям для организации

С точки зрения последствий для организации выделяют функциональные и дисфункциональные конфликты [4; 5; 9]. Функциональные конфликты способствуют уточнению целей, улучшению качества решений, выявлению проблемных зон и стимулированию изменений. Дисфункциональные конфликты приводят к снижению продуктивности, росту текучести персонала, ухудшению климата и подрыву доверия. При этом один и тот же конфликт может иметь смешанные последствия: например, в краткосрочной перспективе он ухудшает атмосферу, но в долгосрочной – способствует реформированию несправедливой системы.

Классификация конфликтов по перечисленным основаниям не является исчерпывающей, но позволяет менеджеру более точно диагностировать конкретную ситуацию, выделить доминирующие факторы и подобрать релевантные методы управления.

4. Функции конфликтов в организации

Функциональный подход к конфликту предполагает анализ тех ролей, которые он играет в жизни организации. Л. Козер одним из первых показал, что конфликты выполняют важные социальные функции, способствуя адаптации групп к изменяющимся условиям и предотвращая застой [6]. В применении к организациям обычно выделяют конструктивные и деструктивные функции конфликтов [1; 3; 6; 9].

4.1. Конструктивные функции конфликтов

К основным конструктивным функциям относятся:

– информационная функция: конфликты сигнализируют о наличии проблемных зон в организации – неэффективных процедур, несправедливых норм, скрытых противоречий между формальной и реальной практикой. Для руководства конфликт служит важным источником информации о реальном положении дел, в том числе о настроениях персонала, уровне доверия к руководителям, восприятию изменений [1; 9; 10];

– диагностическая функция: анализ конфликтов позволяет выявить слабые места в системе управления персоналом, коммуникациях, структуре, системе мотивации. Разбор конфликтных кейсов даёт возможность понять, какие управленческие решения воспринимаются как несправедливые, какие ценности реально доминируют в организации, где нарушается баланс интересов [2; 10];

– интегративная функция: при конструктивном разрешении конфликта укрепляется внутригрупповая сплочённость, формируются более устойчивые нормы взаимодействия, повышается уровень взаимопонимания между участниками [3; 6]. Внешний конфликт с другой группой может усиливать внутреннюю солидарность, однако здесь важно не допустить закрепления деструктивных стереотипов и «образа врага» по отношению к другим подразделениям;

– инновационная функция: конфликты стимулируют выдвижение новых идей, пересмотр устоявшихся практик, поиск альтернативных решений. Столкновение различных точек зрения заставляет стороны аргументировать свои позиции, искать компромиссные варианты и, в конечном счёте, повышать качество принимаемых решений [4; 5]. В организациях, где критическое обсуждение подавляется, инновационный потенциал существенно ниже;

– развивающая функция: участие в разрешении конфликтов способствует личностному и профессиональному росту сотрудников, развитию коммуникативных навыков, формированию компетенций по ведению переговоров, управлению эмоциями, конструктивному диалогу [2; 5]. Для руководителей успешное управление конфликтами становится важным элементом их лидерской эффективности.

4.2. Деструктивные функции конфликтов

При неблагоприятном течении конфликты могут выполнять деструктивные функции:

- дезорганизация деятельности: конфликт отвлекает внимание сотрудников от рабочих задач, нарушает координацию и взаимодействие, приводит к потерям времени и снижению производительности труда;
- ухудшение психологического климата: постоянное напряжение и враждебность в коллективе ведут к стрессу, эмоциональному выгоранию, росту текучести персонала, особенно среди наиболее мобильных и квалифицированных работников [2; 8];
- разрушение доверия: затяжные конфликты подрывают доверие между сотрудниками и к руководству, формируют циничные установки, снижают готовность к сотрудничеству и взаимопомощи;
- блокирование изменений: конфликт может блокировать стратегически важные решения, если превращается в инструмент борьбы за власть или статус. В этом случае любое предложение «противной стороны» отвергается независимо от его содержания, что приводит к консервации неэффективных практик;
- имиджевые и финансовые потери: неуправляемые конфликты, выходящие за пределы организации (например, трудовые споры, публичные скандалы, судебные разбирательства), приводят к ущербу репутации, ухудшению отношений с клиентами и партнёрами, прямым финансовым потерям [9; 10].

Задача менеджмента состоит в том, чтобы усиливать конструктивные функции конфликтов и минимизировать их деструктивные проявления. Для этого используются различные стратегии управления конфликтами: уклонение, сглаживание, компромисс, сотрудничество, конкуренция [4; 5]. Выбор стратегии зависит от значимости предмета конфликта, соотношения сил сторон, срочности ситуаций, особенностей организационной культуры. В долгосрочной перспективе наиболее продуктивной считается ориентация на сотрудничество и поиск решений, учитывающих интересы всех ключевых сторон [5; 10].

Заключение

Организационные конфликты представляют собой неотъемлемый элемент функционирования современных организаций. Их невозможно полностью устранить, да это и нецелесообразно: при правильном управлении конфликты становятся источником развития, инноваций и совершенствования управленческих практик. Теоретический анализ показал, что эволюция научных подходов к конфликту отражает переход от восприятия конфликта как исключительно негативного явления к признанию его потенциала как управляемого ресурса.

Понятие «организационный конфликт» включает ряд ключевых признаков: наличие противоречий между участниками, их осознание, переход к открытому противоборству и влияние на результаты деятельности организации. Классификация конфликтов по уровню участников, по отношению к структуре, по предмету, форме протекания и последствиям позволяет более точно диагностировать ситуацию и выбирать адекватные методы её регулирования.

Функциональный подход демонстрирует двойственную природу конфликта: он способен выполнять как конструктивные функции (информационная, диагностическая, интегративная, инновационная, развивающая), так и деструктивные (дезорганизация, ухудшение климата, разрушение доверия, блокирование изменений). От того, какие механизмы управления конфликтами применяются в конкретной организации, зависит баланс между этими функциями.

Полученные теоретические выводы создают основу для дальнейшего исследования конкретных практик управления конфликтами в организациях, анализа их эффективности, а

также для разработки рекомендаций по формированию организационной культуры, поддерживающей конструктивное разрешение разногласий. Для магистерской диссертации данная статья может служить содержательной базой первой главы, посвящённой теоретическим основам конфликтологии в организационном контексте, с последующим переходом к эмпирическому анализу конфликтов в конкретной компании.

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Medical Sciences

Influence of Obesity Types on the Course of Hypertension and Assessment from the Perspective of Quality of Life

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Abstract

This article presents a comprehensive study of the influence of different types of obesity on the course, clinical characteristics, and quality of life of patients with arterial hypertension (AH). The main objective of the study is to comparatively analyze how various morphological forms of obesity (abdominal and general) affect the clinical manifestations, severity of hypertension, and both physical and psycho-emotional components of patients' quality of life.

During the research, the interrelation between obesity types and the course of arterial hypertension was determined through evaluation of patients' body mass index (BMI), waist circumference, blood pressure levels, cardiovascular functional status, and SF-36 quality-of-life indicators. The obtained results allowed to clarify the role of obesity types in the pathogenesis of hypertension.

The study demonstrated that patients with abdominal obesity experience a more severe course of hypertension and significantly reduced quality of life. These findings substantiate that the type of obesity plays a crucial role in exacerbating hypertension and determining the overall well-being of patients.

Keywords: arterial hypertension, obesity types, abdominal obesity, quality of life, QoL, metabolic disorders

Introduction

Currently, arterial hypertension and obesity are among the most significant global public health issues. These two conditions frequently coexist and are characterized by a complex pathophysiological interrelationship. In particular, **abdominal (visceral) obesity** is regarded as a factor that aggravates the course of hypertension and decreases patients' quality of life.

This study aims to analyze the impact of different types of obesity on the progression of hypertension and assess their influence on patients' quality of life. According to research, abdominal obesity represents the accumulation of fat in the abdominal region, which increases the risk of metabolic syndrome and cardiovascular diseases. It also contributes to insulin resistance and severe forms of hypertension.

Regardless of its type, obesity has detrimental effects on human health, particularly in patients with cardiovascular diseases, in whom it further reduces quality of life. Such patients frequently experience dyspnea, reduced glucose tolerance, and have a higher incidence of life-threatening conditions such as stroke and myocardial infarction. Therefore, obesity is considered one of the major **modifiable risk factors** for arterial hypertension.

Materials and Methods

The study included **100 patients** diagnosed with arterial hypertension — 56 females and 44 males, predominantly of working age. During the initial examination, anthropometric parameters were measured, and participants were classified according to obesity type based on BMI and waist circumference.

- **General obesity:** BMI ≥ 30 kg/m²
 - *Degree I:* 30.0–34.9 kg/m² — Mild obesity
 - *Degree II:* 35.0–39.9 kg/m² — Moderate obesity
 - *Degree III:* ≥ 40.0 kg/m² — Severe (morbid) obesity
- **Abdominal obesity:** waist circumference ≥ 88 cm for women and ≥ 102 cm for men.

Quality of life was assessed using the standardized **SF-36 questionnaire**. The severity of hypertension was determined according to the **European Society of Cardiology (ESC) and European Society of Hypertension (ESH) Guidelines, 2023**. Statistical analysis was performed using **SPSS version 25**.

Results and Discussion

Among patients with abdominal obesity, **grade 2–3 hypertension** was more frequently observed ($p < 0.05$). The study confirmed that obesity, especially the **visceral type**, increases the risk of developing hypertension by 2–3 times. Abdominal obesity was more common among men (68%), and this group demonstrated a higher prevalence of severe hypertension.

According to **SF-36** data, patients with abdominal obesity had significantly reduced physical and psychosocial quality-of-life scores. Although patients with general obesity also showed impaired quality of life, the decline was less pronounced compared to those with abdominal fat accumulation.

Based on anthropometric and clinical data, obesity was classified as follows:

1. **Abdominal (visceral) obesity:** fat accumulation in the abdominal region, directly increasing the risk of cardiovascular diseases and hypertension.
2. **General (diffuse) obesity:** uniform distribution of adipose tissue throughout the body; contributes to hypertension but to a lesser extent.
3. **Composite obesity:** combination of abdominal and general fat deposition, posing the greatest risk for severe hypertension.

The findings indicate that abdominal obesity exerts the most pronounced influence on the severity and persistence of hypertension. Patients with this form exhibited higher blood pressure values, reduced response to antihypertensive therapy, and more pronounced metabolic disturbances — including **insulin resistance, dyslipidemia, and hyperuricemia**. These mechanisms collectively contribute to sustained hypertension and increase the risk of cardiovascular complications.

Therefore, accurate identification of obesity type is essential for optimizing hypertension management and implementing targeted preventive strategies. Clinical practice should adopt an individualized approach that considers the patient's anthropometric and metabolic characteristics.

Conclusion

Obesity is a chronic metabolic disease characterized by excessive accumulation of adipose tissue in the body. Regardless of its type, obesity negatively affects overall health and contributes to metabolic and cardiovascular disturbances.

The study confirmed that different obesity types significantly influence both the clinical course of arterial hypertension and patients' quality of life. In particular, **abdominal obesity** is associated with more severe forms of hypertension and a marked decline in quality-of-life indicators. Such patients commonly experience reduced physical activity, sleep disturbances, emotional instability, fatigue, and decreased social engagement.

In contrast, patients with general (diffuse) obesity demonstrate a milder course of hypertension and relatively higher quality-of-life scores. Thus, when managing hypertension, it is essential to adopt an integrated approach that takes the **type of obesity** into account.

Even modest weight loss (5–10%) can reduce blood pressure by an average of **5–10 mmHg**. Lifestyle modification — including a balanced diet, regular physical activity, and weight control — remains a key component in both the prevention and treatment of hypertension among obese patients.

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ANATOMICAL FEATURES OF LYMPHATIC OUTFLOW IN THE MAMMARY GLAND

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Relevance. This study examines the anatomical features of mammary gland lymphatic drainage and their role in the process of lymphatic metastasis of cancer.

The relevance of the topic is due to the high prevalence of breast cancer among women and the need for a deeper understanding of the anatomical patterns of lymphatic drainage to improve the effectiveness of diagnosis and treatment of oncological diseases [1-4].

Purpose of the study. The purpose of this study is to thoroughly examine the structure of the mammary gland lymphatic system, determine the main directions of lymphatic drainage, and analyze their clinical significance in metastasis.

Research materials and methods. For this project, three databases (PubMed, Scopus, and Web of Science) were used to conduct a comprehensive literature search. A systematic search was conducted using the following keywords: mammary gland, lymphatic vessels, arteries, veins, and capillaries.

The selected articles were reviewed and analyzed to identify key findings related to the anatomy and physiology of mammary lymphatic drainage. The statistical data from the Almaty Kazakh Scientific Research Institute of Oncology and Radiology (KazNIOR) were used to determine the incidence of breast cancer lymph node metastasis.

Results and discussion. This paper examines the macro- and microscopic features of the mammary gland, the anatomy of lymphatic vessels and regional nodes, and their role in tumor cell dissemination.

Particular attention is paid to the axillary, parasternal, and subclavian lymphatic drainage pathways, which are the main routes for lymphogenous metastasis. The main lymphatic drainage collectors in the mammary gland were identified: the intercostal-parasternal and axillary-subclavian.

The axillary pathway accounts for approximately 80% of lymphatic drainage, the parasternal pathway for 15%, and the remaining 5%. The practical significance of the study lies in the possibility of using anatomical data in planning surgical operations, determining the extent of lymph node dissection, and predicting the course of oncological processes. Полученные сведения могут быть применены в клинической практике, медицинском образовании и разработке методических пособий по анатомии и онкологии. The obtained information can be applied in clinical practice, medical education and the development of teaching aids on anatomy and oncology.

A comprehensive literature review yielded valuable information on the anatomy and physiology of mammary lymphatic vessels. Clearly, understanding mammary lymphatic drainage is crucial for the diagnosis, management, and treatment of various breast cancers.

UDC: 616-006-071(574)

METHODOLOGY AND RESULTS OF SCREENING PROGRAMS FOR DETECTION OF BREAST, CERVICAL AND COLORECTAL CANCER IN KAZAKHSTAN

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Annotation: In this scientific and analytical work, the indicators of incidence and mortality from cervical cancer, breast cancer and colorectal cancer in the regions of our country are considered. The screening methods currently used and the results of this preventive survey of the population are described in detail. Detailed step-by-step algorithms are presented, and the principles of organization and diagnostic capabilities of the screening program for the active detection of these nosological forms of malignant neoplasms in clinically asymptomatic individuals are reflected.

Key words: oncological screening, primary care, cervical cancer, breast cancer, colorectal cancer, epidemiology, incidence, mortality, Pap test, smear for oncocytology, ultrasound examination, mammography, hemocult test, fecal occult blood test - FOBT, total colonoscopy.

Today, one of the most important postulates of the oncology service continues to be the early diagnosis of malignant tumors. The purpose of screening is to identify asymptomatic (preclinical) cancer or precancerous conditions in an otherwise healthy target population. In this case, screening plays a leading role in secondary cancer prevention. The key concept of cancer screening is to identify pathology at a stage of development when the effectiveness of treatment is maximum and the prognosis is most favorable. When precancerous diseases are detected during screening, secondary prevention methods allow to prevent the transition of the initial pathological state to cancer. In this case, the main conditions for screening are the presence of trained personnel and a standard approach to identifying the trait being studied and evaluating the results. The methods used must be sufficiently simple, reliable and reproducible, as well as have sufficient sensitivity and high specificity [1-3].

Screening plays an important role in improving early diagnosis and treatment outcomes. According to the Guide to Cancer Early Diagnosis by Ilbawi A. et al. [4], screening aims to detect unrecognized cancer or its prior lesions in a typically healthy, asymptomatic population through tests or other procedures that can be applied quickly and are widely available to the target population. In screening, the target population is assessed for unrecognized cancer or precancer, and most people tested will not be diagnosed with the disease. Screening should be seen as a process and not as the performance of a specific test, examination, or procedure. The screening process includes a system of informing and inviting the target population to participate; administering the screening test; following-up with test results and referral for further testing among those with abnormal test results; ensuring timely pathologic diagnosis, staging and access to effective treatment with routine evaluation to improve the process. A screening program encompasses the process from invitation to treatment and requires planning, coordination and monitoring and evaluation.

To date, the republican oncological screening program includes three nosological forms of malignant neoplasms - cervical cancer (CC), breast cancer (BC), colorectal cancer (CRC). Let's consider the current epidemiological indicators, methodology and results of cancer screening in our country.

CC in the structure of all malignant tumors of both sexes of the population in 2022 took 6th place with a share of 5.51% (2021 - 4th place, 5.54%), in women - stable 2nd place - 9.7% (9.7%) [5].

The incidence rate per 100 thousand population increased from 9.4 to 9.92. In 10 regions of the republic, the incidence rate is higher than the national average: Pavlodar - 17.2 per 100 thousand people (2021 – 16.7) – the highest level, East Kazakhstan – 14.3 (10.8), North Kazakhstan – 14.3 (10.2), Atyrau – 13.2 (13.8), Zhetysu - 11.7, Karaganda - 11.7 (12.0), Abay - 11.1, Akmola - 11.1 (11.9), Mangistau - 11.1 (9.7), Kostanay - 10.8 (10.6) regions.

Low incidence rates in Zhambyl region - 5.8 per 100 thousand population (5.7), Turkestan region - 6.1 (5.2), Aktobe region - 8.3 (11.6), Kyzylorda region - 8.5 (8.2) areas.

CC in the structure of causes of death from malignant tumors of the population of both sexes in 2022 rose from 9th to 8th position, with a share of 4.6% (2021 - 4.3%), mortality from CC is stable at 3.1 per 100 thousand population (3.1).

The mortality rate from CC in 10 regions is higher than the national average: Akmola - 4.2 per 100 thousand population (2021 - 3.1) - maximum level, West Kazakhstan - 4.1 (4.8), Pavlodar - 3.8 (5.6), Almaty – 3.7 (2.5), Zhetysu – 3.7, Atyrau – 3.4 (4.0), East Kazakhstan – 3.3 (3.8), Karaganda - 3.2 (4.7), Kostanay - 3.2 (2.4) regions and Almaty city - 3.4 (2.9).

Below the national average, mortality was recorded in Abay region, cities Astana, Shymkent - 2.9 per 100 thousand population, Mangistau - 2.8 (3.0), Turkestan - 2.3 (2.2), Aktobe - 2.2 (3.0), North - Kazakhstan - 2.0 (2.6), Kyzylorda regions - 1.7 (3.5) - the best result [5].

In 12 regions, a 100% level of morphological verification of the diagnosis was ensured, the

lowest or worst indicator for the third year was in the Kyzylorda region - 94.3%, below the national average indicators in Akmola - 98.8%, Atyrau - 98.9%, Kostanay - 98, 9%, Mangistau - 97.6%, Pavlodar - 96.6%, regions and Almaty city - 98.5%;

In a number of regions, the frequency of diagnosis of stage I-II CC was below the national average (88.1%) - in Akmola - 76.2% (2021 - 73.6%) - the worst result in the country, in Karaganda - 77, 2%, Zhetysu - 82.9%, Abay - 83.8%, Kostanay - 84.3%, Aktobe - 85.5%, West Kazakhstan - 85.7%, Pavlodar - 81.3%, while that in the Atyrau region - 100.0% result.

The proportion of stage IV CC is higher than the national average (2.7%) in the following regions: the worst result is in Zhetysu (6.1%), above the national average in Karaganda - 5.1% (2021 - 5.6%), Akmola - 4.8% (2.3%), Kostanay - 4.5% (4.4%), North Kazakhstan - 3.9% (7.4%), Almaty - 3.7 % (5.1%), Zhambyl - 2.9% (0.0) regions, cities Almaty – 3.6% (1.8%) and Shymkent – 3.8% (5.9%). The lowest neglect is in the East Kazakhstan region - 1.0% (0.7%).

Late diagnosis rates (III-IV stages) for CC are above the national average - 11.9% (15.4% in 2021) were noted in Akmola - 23.8% (2021 - 26.4%) - worst result, Karaganda - 22.8% (35.2%), Pavlodar - 18.8% (20.8%), Zhetysu - 17.1% (24.2%), Abay - 16.2% (12.8%), Kostanay - 14.6% (15.6%), Aktobe - 14.5% (9.6%), West Kazakhstan - 14.3% (32.4%) regions. The lowest neglect is in the Mangistau region - 6.0% (20.8%).

Across the country, the five-year survival rate of patients with CC registered in 2018 was 59.9% in 2022, with a decrease from the level of 2021 (67.5% for those registered in 2017), and with a significant range in by region, from the maximum – 72.9% (2021 – 70.7%) in the North Kazakhstan region, to the minimum – 34.9% (64.4%) in the Atyrau region [5].

CC screening is a periodic, comprehensive examination of women of a certain age group as part of a special medical program to prevent and reduce incidence and mortality from CC.

Type of screening - population. The purpose of screening is to identify pre-invasive diseases of the cervix with subsequent recovery. The screening method is a cytological examination of a smear for oncocytology from the cervix (traditional and liquid cytology). Coloring according to the "Papanicolaou test" (Pap test). Interval - 1 time in 4 years. Target group: women aged 30-70 years who are not registered in the dispensary for CC. The expected results are a decrease in incidence and mortality from CC.

Screening steps:

1) Preparatory - formation of target groups, information support and invitation to screening. The preparatory stage is carried out by the nurses of the primary health care organization responsible for preventive measures and includes: annual compilation of a list of women subject to screening in the coming year by November 15 of the current year, followed by monthly correction; informing target groups of the female population about the need for screening; screening invitation; ensure timely screening.

2) Screening - filling out a statistical card of a preventive medical examination (screening) of an outpatient (form 025-08/y), a register of patients subject to cytological screening and taking material for cytological examination from the cervix. The screening examination of the target groups of the female population is carried out by a specially trained midwife of the primary health care organization.

3) The final one is obtaining the results of cytology, informing the woman and developing further management tactics, fill out accounting and reporting statistical documentation. Responsible for the final stage of screening is the obstetrician-gynecologist of primary health care [6].

Cytological screening of CC is a complex of organizational and medical measures aimed at early detection of precancerous and neoplastic diseases of this localization and at reducing the mortality of this cohort of patients. For traditional cytology, a smear containing 8-12 thousand cells of stratified squamous epithelium (including cells of metaplastic epithelium) is considered

adequate; for liquid cytology - 5 thousand cells. For both methods, the number of cells of endocervical epithelium and/or metaplastic epithelium (from the transformation zone) must be at least 10 (single or in clusters). If more than 75% of the cells of the stratified squamous epithelium are covered with erythrocytes, leukocytes, etc., then the quality of the smear is considered unsatisfactory.

Interpretation of the results of a cytological study is carried out according to the Bethesda-terminology cytological system:

Intraepithelial changes and malignant processes are absent (NILM). This group includes cytological conclusions about the normal state of the epithelium, as well as the presence of various non-neoplastic diseases. Normally, squamous epithelial cells, groups of cells of columnar epithelium and metaplastic epithelium, a small number of leukocytes, and rod/mixed microflora are found in preparations. In the presence of non-neoplastic processes, their nature and, if possible, the cause are specified: atrophic changes, reactive changes associated with inflammation, including typical regeneration. In addition, the presence of microorganisms is indicated: *Trichomonas vaginalis*, fungi, morphologically corresponding to *Candida* spp., bacterial vaginosis, cellular changes corresponding to the defeat of Herpes simplex virus, squamous epithelial cells with atypia of unknown significance (ASC-US), squamous epithelial cells with atypia of unclear significance, not excluding the presence of a high degree of intraepithelial changes (ASC-H). Low-grade squamous intraepithelial changes (LSIL) include lesions associated with HPV and CIN I, high-grade squamous intraepithelial changes (HSIL) include CIN II, CIN III, carcinoma in situ and cases suspected of invasion, squamous cell carcinoma, cervical (glandular) epithelium with atypia of unknown significance, cells of the cervical (glandular) epithelium, possibly neoplasia, endocervical adenocarcinoma in situ, endocervical adenocarcinoma, endometrial adenocarcinoma, secondary adenocarcinoma, unclassified carcinoma, other malignant tumors.

There are certain features when taking material for oncocytology: firstly, the examined woman should be informed about the exclusion of sexual intercourse, vaginal manipulations, including douching, baths, tampons, etc. 2 days prior to sampling. Taking material for cytological examination is carried out by the midwife of the examination room of the department of medical examinations of the primary health care organization: the traditional method (2 glasses - with obligatory fixation in 96% alcohol, it is preferable to use glass slides with a polished edge, which are easily marked) or the liquid cytology method (one container with stabilizing liquid); the code or surname of the patient, identical to the code and surname in the form for sending material for cytological examination, should be clearly marked on the glasses or container [6].

At the same time, when using the traditional method, the biomaterial is delivered to the cytological laboratory as soon as possible after its collection in specialized containers for glass slides with 96% alcohol. If there are visible visual changes in the cervix, then the material is taken from the woman and, without waiting for the results, she is referred for an examination by an obstetrician-gynecologist.

A cytological study is carried out in centralized cytological laboratories at oncological institutions, where an archive of cytological preparations of patients involved in the screening examination is formed, regardless of the result, for a period of at least 10 years with the formation of a computer database.

What material and technical equipment is required to take material for a Pap test? It is as follows: soap and water for washing hands, a light source for cervical examination, a gynecological chair, a disinfected speculum and gloves, an Eyre spatula, a glass slide and a marking pen, a container with a stabilizing solution for liquid cytology, a fixative solution (96% alcohol), a container with warm water for lubricating and warming the vaginal mirrors, a 0.5% chlorine solution for disinfecting gloves and instruments, or another approved for this purpose. And, of course, the registration form itself.

For carrying out liquid cytology, you additionally need: a disposable cervix brush, a container with a stabilizing solution for liquid cytology, and a fixing solution.

At the same time, a smear for oncocytology cannot be taken: during menstruation, earlier than 48 hours after sexual contact or after using lubricants, vinegar or Lugol solution, tampons or spermicides, after vaginal examination or douching, and also during the treatment of genital infection.

Now, regarding the results of CC screening. In 2022, 771,282 women of the target group aged 30 to 70 years were examined during cytological screening (in 2021 - 757,454).

During cytological screening in 2022, 392 cases of cervical cancer were identified (319 in 2021). The detection rate increased from 0.42 to 0.51 per 1000 women examined

High detection of CC during screening is ensured in Aktobe, Almaty, Atyrau, East Kazakhstan, Kyzylorda, Pavlodar, North Kazakhstan, Turkestan regions and Shymkent city. The detection rate in these regions ranges from 0.55 to 1.59 per 1000 women examined. The best indicator is in Atyrau region - 1.59. Compared to 2021, there is an increase in detection in 10 regions, with the exception of Akmola, Aktobe, Zhambyl, Kostanay, Mangistau, North Kazakhstan regions and Shymkent city. The worst result in Astana is 0.15 per 1000 women examined [5].

Cytologically, cervical precancer was detected in 1.16% of those examined (2021 – 0.99%). The detection rate of precancer below 0.6% (the planned indicator for 2022, according to the Comprehensive Plan) was noted in Aktobe, Karaganda and Kostanay regions.

A high proportion of stage I CC (70% or more) was detected in 6 regions of the country (in 8 in 2021): Kostanay, Mangistau (94.7% - best result), North Kazakhstan, Turkestan regions, cities Almaty and Astana. Low levels of early detection of CC (below 50%) were not observed in any region.

Localized processes (stages I-II) were identified in 99.2% of all cases of detected cancer (96.5%). In the Akmola and Karaganda regions, cases of CC were identified not only in localized, but also in widespread stages of the process. A total of 3 cases of CC in stage III and no cases in stage IV were identified (11 and 0, respectively) [5].

BC ranks first in the structure of the frequency of malignant tumors of both sexes in the population with a share of 14.7% (2021 - 15.4%). This situation has been stable since 2004; in addition, BC ranks first and remains consistently in this position in the structure of female oncopathology. The incidence of BC in 2022 in the country as a whole increased to 26.5 per 100 thousand (2021 – 26.3). In the structure of cases, BC occupies the 1st ranking place in the vast majority of regions and cities of the country, except for three: Akmola, Kyzylorda and North Kazakhstan regions, where lung cancer takes the 1st ranking place [4].

Above the national average - 26.5 per 100 thousand of us. – incidence of BC in 10 regions of the country: Abay – 33.3, Akmola – 32.7 (2021 – 29.8), East Kazakhstan – 44.7 (39.9) – the highest level, West Kazakhstan – 31.2 (28.4), Karaganda – 40.2 (40.1), Kostanay – 37.5 (35.8), Pavlodar – 43.2 (47.4), North Kazakhstan – 34.7 (38.2) regions and Almaty city – 35.4 (34.5), Astana city – 31.5 (28.4). Below average indicators per 100 thousand of us. in Aktobe - 21.6 (24.3), Almaty - 21.9 (17.7), Atyrau - 22.8 (15.7), Zhambyl - 14.2 (15.1), Zhetysu - 22.8, Kyzylorda - 14.6 (14.4), Mangistau - 14.7 (17.3), Turkestan - 11.3 (11.7) regions and Shymkent city - 14.9 (21.9) [5].

BC ranks third in the structure of causes of death from malignant tumors in the population of both sexes for the thirteenth year in a row, amounting to 8.1% in 2022 (2021 – 8.7%). In the republic as a whole, mortality from BC decreased by 13.0%, from 6.2 to 5.4 per 100 thousand people.

The regions where mortality from BC is higher than the national average include: Abay - 10.1 per 100 thousand people (maximum level), East Kazakhstan - 8.0 (2021 - 8.5), Pavlodar - 7.1 (10.0), North Kazakhstan - 7.0 (11.4), Kostanay - 6.9 (7.5), Akmola - 6.5 (8.2), West Kazakhstan - 5.7 (6.9), Zhambyl - 5.5 (4.8) and Astana city – 6.3 (6.6), Almaty city – 6.6 (9.5). The indicators are

significantly lower in Aktobe - 4.5 (3.5), Almaty - 4.5 (5.8), Zhetysu - 4.0, Atyrau - 3.7 (3.0), Kyzylorda - 4.4 (4.1), Turkestan - 3.6 (3.6), Mangystau regions - 2.7 (3.6) - the lowest level [5].

Mass screening to identify BC patients should mainly involve healthy women without any signs of the disease or symptoms. Screening not only helps to detect hidden forms of cancer that can be treated, but also has psychological value for women. As a result of screening, women are convinced that they do not have BC, and this is the most important potential success of such programs. While the ultimate goal of screening is to reduce BC mortality, its immediate goal is to detect cancer before clinical manifestation. However, BC is a heterogeneous disease, which can significantly affect the effectiveness of screening. Screening models for BC are usually based on the fact that the majority of detected tumors are invasive cancers in the early stage of progression. In addition, it must be taken into account that the detection of cancer (or its precursors) before clinical manifestation increases the risk of false positive diagnosis [7,8].

Mammography has a sensitivity of 95% and a specificity of 97%. These indicators decrease when examining women with denser mammary glands (young age, use of hormone therapy), with low quality mammography, and also with insufficient qualifications of the radiologist. Detection of high-grade invasive cancer by screening, when the tumor is not yet detected by clinical examination (palpation), means the possibility of reducing mortality from BC [9].

Preventive screening for early detection of BC in the Republic of Kazakhstan includes [10]:

1) mammography of both mammary glands in two projections - direct and oblique in the mammography room of the city, district polyclinic (mobile medical complex). All digital mammograms in the presence of a system for archiving and transferring medical images are copied to CDs and other electronic media and transferred to the server of the mammography room of the Cancer Center using specialized licensed software integrated between medical organizations; in case of impossibility of digital transmission - they are printed on X-ray film at a scale of 1:1 - 100% (1 patient - 1 set - 2 or 4 mammograms) with subsequent transfer to the mammography room of the Cancer Center;

2) interpretation of mammograms according to the BI-RADS classification (M0t, M0d, M1, M2, M3, M4, M5) by two or more independent radiologists of the same medical organization - double reading or different medical organizations: a radiologist of the mammography room city, district polyclinic (mobile medical complex) - the first reading, and the radiologist of the mammography room of the Cancer Center - the second reading;

3) in-depth diagnostics - targeted mammography, ultrasound examination (hereinafter - ultrasound) of the mammary glands, trepanobiopsy, including under ultrasound or stereotaxic control for histological examination, which is carried out in case of detection of pathological changes on mammograms (M0d) in the mammography room of the Cancer Center.

√ An average medical worker or a responsible person of the organization of outpatient care sends the patient for mammography to the district, city polyclinic.

√ The X-ray laboratory assistant of the mammography room of the city, district polyclinic (mobile medical complex) performs mammography, fills out a referral for double reading of mammograms and transmits the referral through information interaction.

Radiologist of the mammography office of the city, district polyclinic (mobile medical complex): fulfills the requirements for the safety and quality of mammographic examinations; evaluates the quality of the images provided and the correctness of the installation; performs repeated mammography in the M0t category (technical errors of mammography); determines the radiological density of the mammary glands on the ACR scale (A, B, C, D) indicating this parameter in the study protocol; conducts the first reading of mammograms with interpretation of the BI-RADS classification results. In the M0d category (undetermined or suspicious radiological changes requiring additional examination), the study protocol indicates the predominant pathology: education, asymmetry, violation of architectonics, microcalcifications; sends mammograms,

electronic copies of mammograms through the archiving system and transfer of medical images to the workplace of the mammography office of the Cancer Center together with directions for double reading of mammograms; directs low-dose computed tomographic images through the system of archiving and transferring medical images to the workplace of the computer tomography office of the Cancer Center together with copies of images recorded on CD-ROMs or other electronic media and directions for double reading.

◆ The radiologist of the mammography room of the Cancer Center: evaluates the quality of the provided images and the correctness of the styling. Viewing digital x-ray images transferred to the server or on digital media (CD, DVD) is carried out on a monitor for interpreting digital x-ray images with a resolution of at least 5 megapixels, which has a certified grayscale transmission in accordance with the DICOM standard; conducts a double (second) reading of mammograms with the interpretation of the results according to the BI-RADS classification, using, if necessary, archival images. Organizes the third reading according to indications. With double reading, an independent interpretation of the images is carried out (blinding method - the second radiologist does not know the results of the first reading); in the M0m category (technical errors in mammography), recommends repeat mammography; in the M0d category (uncertain or suspicious radiographic changes requiring additional examination), the study protocol indicates the predominant pathology: education; asymmetry, violation of architectonics, microcalcifications; recommends that the outpatient care organization, according to indications, invite the patient for in-depth diagnostics (targeted mammography, ultrasound of the mammary glands, trephine biopsy, including under ultrasound or stereotaxic control, followed by histological examination of the material); collects and archives all mammograms (films and electronic media) made as part of the examination. The shelf life of mammograms is at least 3 years after leaving the age subject to a screening study; the results of the double (second) reading are transferred to the outpatient care organizations through information exchange.

◆ Indications for in-depth diagnostics are the conclusions of double reading mammograms M0d (uncertain or suspicious X-ray changes requiring additional examination).

◆ In-depth diagnostics is carried out in two stages. At the first stage, ultrasound is performed, according to indications, targeted mammography, possibly with an increase (with asymmetry, violation of architectonics and the presence of microcalcifications). When visualizing a suspicious pathology (M4 and M5), the second stage is performed - trepanbiopsy, including under ultrasound control and stereotaxic control for histological examination.

◆ Histological examination is carried out in the laboratory of pathomorphology or pathological bureau. Morphological interpretation of the biopsy is carried out in accordance with the recommendations of the World Health Organization.

◆ Physician or responsible person of the outpatient care organization:
1) upon receipt of a mammography result according to the BI-RADS classification:
- in case of M0t (technical errors in mammography) - sends the patient for a second X-ray examination to the mammography room of the city, district polyclinic (mobile medical complex);
- with M0d (undefined or suspicious X-ray changes requiring additional examination) - sends the patient for in-depth diagnostics to the mammography room of the Cancer Center;
- with M1 (no changes detected) - recommends that the patient undergo a follow-up mammography examination after 2 years. With radiological density of the mammary glands, C and D are sent for ultrasound of the mammary glands to exclude a false-negative result of mammography;
- with M2 (benign changes), refer the patient for a consultation with an oncologist (mammologist) of the clinical diagnostic department, followed by a screening mammography examination after 2 years;
- with M3 (probable benign changes) - sends the patient for short-term dynamic radiation

observation to the local doctor with the recommendation of control mammography or ultrasound in 6 months;

- with M4 (signs that cause suspicion of malignancy), M5 (practically reliable signs of malignancy) and if it is technically impossible to perform a trepanbiopsy or a biopsy is refused, a referral to an oncologist (mammologist) of the clinical diagnostic department for dynamic observation and decision on the verification of the identified pathology;

2) upon receipt of the result of a histological examination:

- benign education - refers the patient to an oncologist (mammologist) of the clinical diagnostic department for dynamic monitoring, followed by a screening mammography examination after 2 years;

- formation with an indeterminate malignant potential or carcinoma in situ - refers the patient to the Cancer Center for consultation and treatment, followed by dynamic observation by an oncologist (mammologist) of the clinical diagnostic department at the place of her attachment;

- malignant neoplasm - refers the patient to the Cancer Center for treatment and follow-up;

3) communicates the results of the screening examination to the patient in any available way (by telephone, in writing, through electronic means of communication);

4) enters the results of double reading, in-depth diagnostics, histological examination, recommendations of the radiologist of the Cancer Center mammography room into the information system.

Establishing the size of the primary tumor is especially important in screening. Tumor size is an important criterion for evaluating the quality of screening and determining the ability of X-ray mammography to detect non-palpable tumors. Therefore, it is extremely important that pathologists measure tumor diameter as accurately as possible. The smaller the size of the primary tumor, the greater the likelihood of error in determining its size.

Let's analyze the results of BC screening. Mammography screening identified 1,570 cases of BC in 2022 (1,402 in 2021). The cancer detection rate increased from 1.78 to 1.94 per 1000 examined. The best result is in the Karaganda region – 2.63 per 1000 women examined. Low detection rate per 1000 examined, compared to the republican average, in Atyrau (1.72), Zhambyl (0.58), Kyzylorda (1.68), Mangistau (0.42 - worst result), Turkestan (1.22) regions and cities Astana (1.5) and Shymkent (1.58). Compared to 2021, there was an increase in the detection of BC in 9 regions, with the exception of Aktobe (decrease from 2.87 to 2.19 per 1000 women examined), Karaganda (from 2.73 to 2.63), Mangistau (from 1.10 to 0.42), North Kazakhstan (from 3.27 to 2.31), Turkestan (from 1.36 to 1.22) regions and cities Astana (from 1.54 to 1.50), Almaty (from 2.24 to 2.18) and Shymkent (from 2.35 to 1.58) [5].

In 2022, the proportion of patients identified during screening studies with early stages of BC (stage 0-I) was 50.2% during screening (in 2021 - 47.9%). A high proportion of stages 0-I BC (over 50%) was recorded in 8 regions (in 8 in 2021): Akmola, West Kazakhstan, Karaganda (70.8% - best result), Pavlodar, North Kazakhstan, Turkestan regions, cities Astana and Shymkent. Low levels of early detection of BC (below 40%) were noted in Aktobe (19.3% - worst result), Zhambyl (34.8%), Kostanay (39.5%), Mangistau (27.3%) regions and Almaty city (37.3%). Localized cancer (0-I and II stages) amounted to 96.2% (2021 - 95.5%), while not a single case was detected in stages III-IV in Atyrau, West Kazakhstan, Zhambyl, Kyzylorda, Mangistau, Pavlodar regions, cities Astana and Shymkent. A total of 46 cases of breast cancer in stage III and 14 in stage IV were identified (52 and 11, respectively) [5].

Epidemiological indicators of CRC in the form of colon cancer and colorectal cancer are considered separately for objective reasons.

Colon cancer with a specific gravity of 5.53% (2021 - 5.2%) in the structure of oncopathology of both sexes of the population has risen to 5th place, in men it remains in 6th

place - 5.8% (5.5 %), for women - in the 5th - 5.3% (4.91%) The incidence rate of cancer of this localization in the country in the reporting year increased from 8.8 to 9.95 per 100 thousand population.

The incidence of colon cancer in 10 regions is higher than the national average - 9.95 per 100 thousand population: Kostanay - 20.7 (2021 - 15.9), Pavlodar - 18.8 (15.3), North Kazakhstan - 18, 0 (12.7), East Kazakhstan - 16.9 (13.4), Karaganda - 15.4 (15.0), Akmola - 14.6 (10.2), West Kazakhstan - 11.0 (10.1), Abay - 10.0 (9.0) regions and cities Almaty – 12.8 (12.1) and Astana – 10.5 (9.0). As in 2021, colon cancer was detected much less frequently in Turkestan - 3.1 per 100 thousand population (2.7), Kyzylorda - 4.1 (4.6), Zhambyl - 5.5 (5.8), Almaty - 6.3 (4.7), Zhetysu - 6.4, Mangistau - 6.8 (4.9) regions and Shymkent city - 5.0 (4.0) [5].

Rectal cancer in the structure of malignant neoplasms of both sexes retains 7th place in rank with a specific gravity of 4.9% (2021 - 4.92%), but in men it dropped from 4th to 5th place - 6.1%, for women – from 9th to 10th – 4.0%. The incidence rate per 100 thousand population increased from 8.4 to 8.8.

A high incidence rate was recorded in Kostanay - 17.8 per 100 thousand population (2021 - 16.2), East Kazakhstan - 17.7 (13.9), North Kazakhstan - 15.6 (15.1), Pavlodar – 14.9 (18.1), Karaganda – 13.3 (11.7), Abay – 12.9, West Kazakhstan – 12.9 (9.8), Akmola – 10.3 (13.1) regions and Astana city – 10.3 (9.0). Traditionally, a low incidence of rectal cancer is observed in Mangistau - 3.1 (2.8), Turkestan - 3.3 per 100 thousand population (2.7), Zhambyl - 3.7 (5.1), Kyzylorda - 4, 1 (5.3), Almaty – 5.3 (5.6) regions and in Shymkent city – 5.5 (5.0) [5].

Rectal cancer in the structure of causes of death from malignant neoplasms of the population of both sexes in 2022 remained in 5th place with a share of 5.41% (2021 – 5.41%). In the republic as a whole, the mortality rate from this form of cancer was 3.6 per 100 thousand population (3.87).

The mortality rate per 100 thousand population was higher than the national average in East Kazakhstan - 7.8 (2021 - 8.6) - the maximum level, Pavlodar - 7.5 (7.6), Abay - 5.9, North Kazakhstan - 5.8 (4.3), Kostanay - 4.9 (4.9), West Kazakhstan - 4.8 (4.2), Karaganda - 3.8 (5.2) regions. Below the national average - 3.8 per 100 thousand population, mortality in Aktobe - 3.2 (4.1), Almaty - 2.6 (2.6), Atyrau - 2.5 (3.4), Zhetysu - 2, 6, Zhambyl - 3.3 (2.7), Turkestan - 2.1 (1.6), Mangistau - 1.9 (1.2), Kyzylorda regions - 1.8 (2.1) - the lowest figure , and cities Almaty – 3.7 (4.3), Shymkent – 2.6 (2.1).

Colon cancer in the structure of causes of death from malignant neoplasms of the population of both sexes in 2022, as in 2021, ranks 6th, with a share of 5.2% (2021 – 5.0%). At the same time, the mortality rate in the country decreased by 5.6%, from 3.6 to 3.4 per 100 thousand population.

Mortality rates in 10 regions are higher than the national average: East Kazakhstan - 7.1 per 100 thousand population (2021 - 5.1) - maximum level, Pavlodar - 5.6 (6.0), Kostanay - 5.3 (5.6), Akmola – 5.2 (3.8), Abay – 5.1, Karaganda – 5.1 (5.6), West Kazakhstan – 4.8 (4.4), North Kazakhstan – 4.8 (5.0) regions and cities Astana – 3.6 (2.7), Almaty – 4.5 (5.3). Low mortality rates from colon cancer were noted in Kyzylorda - 1.2 per 100 thousand population (2.7) - the best result, Turkestan - 1.3 (1.7), Mangistau - 1.6 (2.6), Aktobe – 2.0 (2.5), Zhetysu – 2.4, Zhambyl – 2.5 (3.7), Atyrau – 2.5 (1.8), Almaty – 2.6 (1.8) regions and cities Astana – (2.7), Shymkent – (2.4).

For colon cancer (94.0%) - 100% verification level was achieved in 3 regions (Abay, Almaty and Turkestan regions), high rates in the Astana city (98.5%), Shymkent city (98.0%), Zhambyl (98.4%), Atyrau (98.2%) regions, low – in Akmola region (86.7%), Almaty city (84.3%), in the Kyzylorda region (61.8%) – the worst result since 2017.

For rectal cancer (97.4%) - in 6 regions there is a 100% verification level, the worst level is still in the Kyzylorda region - 85.3%, lower than the republican average in the Akmola region - 92.6%, Aktobe region - 96 .8%, Mangystau region - 87.0%, Pavlodar region - 95.3%, Almaty city -

93.2% [5].

The frequency of diagnosis of stage I-II rectal cancer, as a visually accessible localization (68.9% - national average) in the regions, was: in Akmola - 34.6% - the worst result, as in 2021, in the country (2021 - 44.1%), Mangistau - 47.8%, Abay - 53.9%, West Kazakhstan - 59.1%, Almaty - 66.2%, Zhetysu - 68.6%, Karaganda - 65, 7% regions and Shymkent city - 62.9%.

For colon cancer (52.4%), early diagnosis rates are higher in Pavlodar (65.9% - best result), Abay, Aktobe, Atyrau, East Kazakhstan, Zhambyl, Zhetysu, Karaganda, Kostanay, Pavlodar, North Kazakhstan, Turkestan regions and Shymkent. The lowest figure (23.5%) is in the Kyzylorda region.

For colon cancer (17.3%), the rates of neglect at stage IV are higher - in Akmola - 31.0% - the worst result (2021 - 20.3%), Zhetysu - 27.3%, Abay - 23.1% , Turkestan - 22.2% (29.1%), Karaganda - 28.1% (28.6%), West Kazakhstan - 18.8% (8.2%), Mangistau - 17.6% (19 .4%) regions and cities Astana - 18.0% (22.9%), Shymkent - 20.0% (22.7%). The lowest level of neglect is 2.9% in the Kyzylorda region (7.9%).

The proportion of stage IV in rectal cancer (13.1%) is higher in Akmola - 29.6% - the worst result (2021 - 19.4%), Abay - 19.7%, Kyzylorda - 17.6% (9.1%), Karaganda - 16.9% (28.4%), Almaty - 15.6% (17.0%), Kostanay - 14.8% (11.1%), Zhambyl - 13.3 % (13.6%) regions and Shymkent city - 14.5% (12.5%). The lowest level of neglect - 6.0% - is in the Atyrau region (12.5%).

Late diagnosis of rectal cancer as a visually accessible localization (stages III-IV) in 2022 amounted to 31.1% (in 2021 - 33.5%).

For rectal cancer, the level of neglect is higher than the national average - 31.1%, the indicators in Akmola - 65.4% (2021 - 55.9%) - the worst result in the country, Mangistau - 52.2% (38.1%), Abay – 46.1% (30.6%), West Kazakhstan – 40.9% (25.4%), Karaganda – 34.3% (46.5%), Almaty – 33.8% (35.7 %), Zhetysu - 31.4% (34.1%) regions and Shymkent city - 37.1% (42.9%). The lowest neglect is in the Atyrau region - 12.0% (17.5%).

In the country as a whole in 2022, the five-year survival rate of patients with CRC registered in 2018 decreased to 40.4% (2021 - 52.9% for those registered in 2017); there is a significant dispersion of indicators by region, from maximum – 56.1% (47.5%) in the Kyzylorda region, to minimum – 24.3% (51.5%) in the Aktobe region [5].

Screening of CRC screening is the systematic use of screening studies in an asymptomatic population. The purpose of screening is to identify people with abnormalities suggestive of CRC. These persons in the future need additional examination to clarify the diagnosis. Opportunistic screening is the non-systematic use of screening tests in routine medical practice. A screening program is much more challenging than an early detection program. At the same time, the success of the screening program is largely determined by the awareness of the population and medical workers about the possibilities of early diagnosis of CRC. The feasibility of a screening program is determined by several factors that relate to the disease being screened, the screening test, the characteristics of the population, and the characteristics of the healthcare system.

The first factor is that the disease must be well understood, common enough in the target population to justify screening, have a recognizable early stage; treatment of the disease at an early stage should be more effective than at a later stage.

The second is that the test should be characterized by sufficient sensitivity, i.e. the ability to detect cancer among people with the disease; sufficient specificity - the probability that among people who do not have a disease, the test result will be negative; have a high positive predictive value (positive predictive value) or, in other words, the likelihood that people with a positive test result have the disease; have a high predictive value of a negative result (negative predictive value), i.e. the likelihood that people with a negative test result do not have the disease; security; low cost; and acceptability - the likelihood that people for whom this test is intended will agree to the examination (which to some extent depends on the awareness of the population about the possibilities and importance of early diagnosis).

The third factor is that the healthcare system should be ready for maximum screening test coverage of the target group, have the resources to confirm the diagnosis, appropriate treatment and follow-up of people with positive test results, and regularly conduct screening tests at regular intervals. At the same time, the benefits of screening must outweigh the potential physical and psychological harm and justify the financial costs of its implementation [11].

The factors most significant for the development of CRC are:

- the presence of chronic inflammatory bowel diseases, adenomatous polyps, cancer of other localization, etc.;
- family history (presence of one or two first-degree relatives with CRC or familial diffuse intestinal polyposis);
- the age of men and women over 50 years old, taking into account the fact that more than 90% of patients with colorectal cancer are people of this age (medium risk).

Age, regardless of gender, is an important risk factor for CRC. After the age of 50, the incidence of CRC increases from 8 to 160 per 100,000 population. Thus, people who have reached the age of 50, even in the absence of symptoms, constitute a moderate risk group for CRC.

The second category of increased risk of CRC (20%) is made up of persons with a genetic and family predisposition, suffering from chronic inflammatory bowel diseases, diffuse familial polyposis.

The high-risk CRC group is determined by the so-called Amsterdam criteria (the presence of malignant tumors in two generations, the presence of cancer in a first-line relative under the age of 50 years), in this case, CRC screening should be carried out after the age of 30 years [12].

The degree of individual risk of developing CRC is determined before screening to select the scope of studies and the frequency of their conduct.

The interval for oncological colorectal screening is 1 time in 2 years, target group: men and women aged 50-70 years, with the exception of persons registered at the dispensary for CRC and colon polyposis. At the same time, when forming the target group, one should take into account the absence of severe concomitant diseases, such as the presence of a common malignant neoplasm, cerebrovascular diseases in the stage of decompensation, chronic obstructive pulmonary disease with respiratory failure, cirrhosis of the liver, myocardial infarction with congestive heart failure, diabetes mellitus with vascular complications. and others, which are highly likely to lead to death in the next 10 years.

The first step in screening for CRC is the fecal occult blood test (FOBT). Traditionally, such methods include a benzidine test for occult blood in the feces. This is a biochemical method based on the assessment of pseudoperoxidase activity of hemoglobin. There is ample evidence that invitation to guaiac FOBT screening (gFOBT) reduces CRC mortality by approximately 15% in age-matched average-risk populations.

To ensure the effectiveness of screening with gFOBT, the interval for screening under the national screening program should not exceed two years. To date, there is an immunochemical FOBT method - iFOBT, which is superior in efficiency to gFOBT in terms of the probability of detecting adenoma and cancer. iFOBT has improved analysis performance compared to gFOBT.

Immunochemical (immunochromatographic) examination of feces for occult blood - iFOBT or hemocult test is carried out for all men and women of the target group using an express method, which allows you to get a result within 3-5 minutes, without the participation of a medical worker. However, the evaluation of the test is carried out only by a medical worker in the PHC preventive department.

With a positive analysis of feces for occult blood, the second stage of colorectal screening is performed, which consists in endoscopic examination of the colon - total colonoscopy [6]. At the same time, in this case, this medical manipulation is of a therapeutic and diagnostic nature, since it allows one-stage removal of adenomatous polyps, which, according to various authors,

occur in every third subject after 50 years of age. At the same time, women have 20% fewer polyps than men, but they have more right-sided lesions, which are more difficult to detect using fecal blood tests, because they are less traumatic [13,14].

What results were obtained from screening for CRC? In 2022, 937,859 men and women of the target group aged 50 to 70 years were examined during colorectal screening (in 2021 - 920,640) [5].

Colorectal screening revealed 325 cases of colorectal cancer in the reporting year, which is 114 cases more than in the previous year (211 cases). The detection rate increased from 0.23 to 0.35 per 1000 patients examined. Low detection of colorectal cancer was noted in Zhambyl, Karaganda, Kostanay, Kyzylorda, Mangistau, Turkestan - the worst result, East Kazakhstan regions, Astana city - from 0.07 to 0.30 per 1000 examined. The best result is in the North Kazakhstan region – 0.81 per 1000 examined. Compared to 2021, there was a decrease in the detection of colorectal cancer per 1000 people examined during screening in Karaganda (from 0.22 to 0.21), Kostanay (from 0.29 to 0.28), Mangistau (from 0.20 to 0.12) regions and Astana city (from 0.20 to 0.19).

Colon precancer (adenoma detection rate) was detected in 27.5% of patients who underwent colonoscopy (2021 – 22.8%). The detection rate of precancer in Akmola, Aktobe, Almaty (8.5% is the worst result), West Kazakhstan, Zhambyl, Kostanay, Kyzylorda, Mangistau, Pavlodar, North Kazakhstan, Turkestan regions and cities is lower than the national average Astana and Shymkent. The best result is 36.2% in Almaty city. It should be noted that the planned indicator for the detection of precancer of the colon and rectum in the country for 2022, according to the Comprehensive Plan, was 23.0% and was achieved.

In 2022, the proportion of patients identified during screening studies with early stages of malignant neoplasms (stages 0-I) was 26.2% during colorectal screening (in 2021 - 27.5%).

High early detection of colorectal cancer (above 30%) was noted in Akmola, West Kazakhstan, Karaganda, Kostanay, Kyzylorda, Turkestan regions and Astana city (57.1% - the best result). Not a single case of early cancer has been identified in the Mangistau region. Cases of cancer in stages III-IV detected during screening were registered in Akmola, Aktobe, Almaty, West Kazakhstan, Zhambyl, Karaganda, Kostanay, Mangistau regions and Almaty city. A total of 21 cases of colorectal cancer in stage III and 3 in stage IV were identified (in 2021 - 18 and 5, respectively) [5].

The complex analysis carried out allows us to conclude that satisfactory results of cancer screening can be achieved only with its proper organization, high quality of implementation, active participation in population screening, the use of highly sensitive tests and instrumental methods of preventive examination, as well as subsequent accurate diagnosis of identified tumors and timely treatment. High-quality screening leads to early diagnosis of pedological diseases and malignant pathology in the early stages, which, in turn, increases the effectiveness of treatment and improves the prognosis of the disease. Target groups that, for one reason or another, do not participate in screening should be informed that there are no other methods other than screening that would reduce mortality from malignant neoplasms. Incidence and mortality rates from cervical cancer, breast cancer and colorectal cancer clearly reflect the epidemiological situation with this pathology in the regions of our country.

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ОСОБЕННОСТИ РЕАГИРОВАНИЯ ПЕЧЕНИ ПРИ ЭКЗОТОКСИКОЗЕ И КОРРЕКЦИИ

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Введение. Печень, как своеобразная лаборатория оказывает существенное влияние на гомеостаз организма и в ряде случаев может определять исход того или иного патологического состояния. Она играет большую роль в регуляции крово- и лимфообращения, как экстракардиальный фактор. Особая роль принадлежит печени в детоксикации экзо- и эндотоксинов.

Целью исследования явилось выявить морфологические особенности печени в условиях нормальной жизнедеятельности, при воздействии 3,4- бензпирена и коррекции биологически активной добавкой «Лимфосан».

Материал и методы. Исследование проводили на 70 крысах – самцах «Вистар», массой тела 180-200 г в возрасте 5-6 месяцев. Подопытные животные были разделены на 3 группы. Первой группе животных - контрольной – в течение 3-х дней вводили внутривентриально по 1 мл оливкового масла. Второй группе - в течение 3-х дней внутривентриально делали инъекции 3,4 – бензпирена по 20мг/кг массы тела в минимальном объеме оливкового масла (0,2-0,3мл). Животные находились на стандартном режиме вивария. Третьей группе животных – по окончании создания модели острого токсикоза добавляли в стандартный виварный рацион «Лимфосан» в течение 10 дней в дозе 1г/кг массы тела. Через 1, 7 и 21 сутки по окончании эксперимента животных декапитировали и забирали кусочки печени для гистологических и электронно- микроскопических исследований.

Результаты и обсуждения. Через 1-е сутки во 2-ой группе животных после введения 3,4- бензпирена при гистологическом исследовании отмечали инфильтрацию клеток крови вдоль триад. В инфильтратах встречались макрофаги, тучные клетки, эозинофилы, нейтрофилы, лимфоциты и плазмциты. Наблюдала стаз эритроцитов в центральных венах. В центролобулярных гепатоцитах отсутствовали признаки деструктивных изменений. В печеночных дольках, ближе к портальным трактам, в гепатоцитах появлялись вакуоли в цитоплазме. Синусоиды печени были значительно расширены. При электронно-микроскопическом исследовании пространство Диссе расширено с элементами погибших гепатоцитов. В гепатоцитах отмечали значительное расширение цистерн гранулярного эндоплазматического ретикулума и комплекса Гольджи. Уменьшалось число прикрепленных и свободных полисомальных рибосом. Митохондрии были в состоянии отека. В печеночных дольках животных 3-ей группы, которым после введения 3,4- бензпирена добавляли в рацион БАД Лимфосан наблюдалось следующее. Вокруг сосудов, клетки сохраняли свое строение. Структура пространства Диссе близка к норме. Не отмечалось нарушения структуры микроворсинок гепатоцитов. При морфометрическом исследовании объемная площадь цитоплазмы гепатоцитов после отравления животных бензпиреном, уменьшилась в обеих группах животных, получавших стандартный рацион, так и с добавлением БАД Лимфосан. Размеры ядер не изменялись. Площадь

синусоидальных пространств возрастала во 2-ой и 3-ей группах животных. Число двуядерных гепатоцитов возрастало. Количество гепатоцитов и синусоидальных клеток значительно не изменялось. На 7-е сутки эксперимента у 2-ой группы животных наблюдали участки некроза гепатоцитов. Просветы синусоидов продолжали оставаться расширенными. Встречались гепатоциты лишенные ядер. Цистерны ГЭР и комплекса Гольджи расширены. При морфометрическом исследовании у животных, получавших с рационом Лимфосан отмечалась тенденция к увеличению числа прикрепленных и полисомальных рибосом. Через 21 сутки после окончания эксперимента в печени животных 3-ей группы не наблюдали деструктивных изменений и наличия инфильтраций клеток крови вдоль сосудов. Перипортальные гепатоциты сохраняли структурную целостность. Хотя во 2-ой группе дистрофические и деструктивные изменения сохранялись, площадь цитоплазмы гепатоцитов и их ядер восстанавливалась. Просветы синусоидов соответствовали значениям в контроле.

Выводы. Таким образом, добавление к стандартному виварному рациону крыс биологически активной добавки Лимфосан способствует более быстрому и полному восстановлению структурной целостности печени.

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Physical and Mathematical Sciences

УДК 37.018.43:004.8

DEVELOPMENT OF A MODEL FOR INTEGRATING ARTIFICIAL INTELLIGENCE INTO THE PROCESS OF TEACHING CASE TECHNOLOGIES

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This paper presents the development of a model for integrating Artificial Intelligence (AI) into the process of teaching case technologies. The integration of AI in education aims to enhance personalized learning, adaptive feedback, and decision-making in the learning process.

The study explores theoretical foundations, reviews current approaches, and proposes a structured AI-based model that supports teachers and students in the application of case technologies. The model emphasizes data-driven analysis, scenario generation, and intelligent evaluation. The implementation demonstrates improvements in engagement and learning outcomes, proving the potential of AI in modern education.

Keywords artificial intelligence, Case technology, interactive learning, digital education, problem solving, ethics, higher education.

Introduction

The rapid advancement of Artificial Intelligence (AI) has significantly impacted various sectors, including education. AI technologies such as machine learning, natural language processing, and intelligent tutoring systems are reshaping how educational content is delivered and how students interact with learning materials. In recent years, the concept of case technologies has become a valuable pedagogical approach, focusing on real-world problem-solving and analytical thinking. However, traditional case-based learning often lacks adaptability and individualized support. Therefore, integrating AI into the process of teaching case technologies offers a promising direction for enhancing efficiency and personalization.

This research aims to develop a model that effectively integrates AI into the teaching process based on case technologies. The proposed model is designed to provide educators with

tools for automating case creation, offering personalized feedback, and supporting student assessment through data analytics.

Literature Review

The literature on AI in education highlights its potential to transform learning environments. AI-powered systems can perform tasks such as predicting student performance, recommending resources, and automating grading. Studies by Anderson (2020) and Nguyen (2022) emphasize that AI-based adaptive learning improves student engagement and knowledge retention. Case technologies, on the other hand, rely on problem-based learning where students analyze practical scenarios and propose solutions. When combined, AI and case technologies create a hybrid learning ecosystem that blends human expertise with machine intelligence.

Prior research indicates that AI can facilitate case generation, automate scenario evaluation, and provide predictive analytics for case outcomes. However, few models focus on integrating AI systematically into the pedagogical structure of case-based education. This study fills that gap by proposing a comprehensive integration model.

Methodology

The research methodology combines qualitative analysis, system modeling, and prototype testing. The process involved three key stages: (1) analyzing educational case technology requirements, (2) designing an AI integration framework, and (3) implementing a pilot version in a controlled educational environment. Data was collected from 50 undergraduate students participating in information systems courses that employed case-based learning. Questionnaires and system logs were analyzed to evaluate the impact of AI tools on learning efficiency and motivation.

Proposed Model

The proposed model for integrating AI into the process of teaching case technologies consists of five key components:

1. Knowledge Database-containing domain-specific case studies and metadata.
2. AI Engine-responsible for natural language understanding, case generation, and feedback automation.
3. Learning Management Interface-connecting students and teachers through a digital platform.
4. Data Analytics Module- monitoring student activity and predicting outcomes.
5. Adaptive Feedback System- offering personalized recommendations based on performance.

This structure enables dynamic case creation and adaptive learning experiences. The AI Engine uses natural language processing to analyze student submissions and generate tailored feedback. The model supports both synchronous and asynchronous learning environments.

Implementation and Results

A prototype of the AI-integrated case learning system was implemented using Python-based machine learning algorithms and a web interface. Students interacted with the platform by solving case problems, receiving AI-generated hints, and submitting their reasoning for analysis. Results showed a 27% improvement in problem-solving accuracy and a 19% increase in student engagement compared to traditional methods.

Teachers reported that the AI system reduced manual grading workload by 40%, allowing more focus on qualitative feedback and student guidance. Statistical analysis confirmed the effectiveness of the model, with significant improvement in learning outcomes ($p < 0.05$).

Discussion

The integration of AI into case-based teaching offers substantial pedagogical benefits. AI not only automates routine processes but also enriches the learning experience through personalization. However, successful adoption requires proper teacher training, ethical

considerations, and continuous monitoring of algorithmic fairness. The proposed model demonstrates scalability and flexibility, applicable across various academic disciplines.

Conclusion

This study developed and validated a model for integrating Artificial Intelligence into the process of teaching case technologies. The results indicate that AI can significantly enhance the efficiency and quality of case-based education by providing personalized learning paths, intelligent feedback, and data-driven decision-making. Future research will focus on expanding the model's capabilities using deep learning and exploring its application in interdisciplinary education.

Theoretical Background of AI in Education

Artificial Intelligence (AI) in education represents a dynamic interdisciplinary field that merges computer science, cognitive psychology, and pedagogy. It is founded upon three essential pillars- machine learning, knowledge representation, and cognitive modeling- each of which contributes to the development of intelligent educational systems.

Machine learning (ML) forms the computational backbone of AI in education. Through algorithms that analyze large volumes of student data, ML models can predict learning outcomes, identify struggling learners, and recommend personalized interventions. For example, supervised learning algorithms can classify student responses, while unsupervised learning techniques such as clustering help group students according to learning patterns and preferences. Reinforcement learning further enhances adaptivity by allowing AI systems to optimize instructional strategies over time based on feedback and performance metrics.

Knowledge representation (KR) provides the structural framework that allows machines to interpret, reason, and manipulate educational content. It transforms instructional materials into digital formats that AI systems can process. Semantic networks, ontologies, and decision trees are common KR techniques that enable systems to map relationships between concepts. In case-based learning, KR allows AI to retrieve relevant past cases, compare them with current learning scenarios, and generate adaptive guidance for students.

Cognitive modeling, meanwhile, aims to replicate human reasoning and problem-solving behaviors within an artificial system. It leverages psychological theories of learning- such as constructivism and metacognition- to design systems that mimic how humans think, learn, and adapt. In educational settings, cognitive models are used to simulate student decision-making, enabling the system to anticipate errors and provide corrective feedback in real time.

In the context of case technologies, AI acts as a cognitive partner to both instructors and learners. It can emulate an instructor's reasoning process, identifying key variables, assumptions, and causal relationships within a given scenario. AI tools can dynamically generate alternative case paths, evaluate student solutions, and provide context-sensitive hints. By doing so, AI transforms case-based education from a static exercise into an adaptive, interactive, and data-informed learning experience.

The integration of these theoretical foundations underscores the potential of AI not as a replacement for educators, but as an enhancement of human teaching capabilities. Through continuous learning and contextual awareness, AI systems contribute to a more intelligent, equitable, and personalized educational ecosystem.

Model Architecture and Workflow. The proposed AI integration model for teaching case technologies is built on a multi-layered architecture designed to ensure modularity, interoperability, and scalability. Each layer performs distinct yet interconnected functions that collectively facilitate adaptive learning experiences. The architecture consists of four sequential layers:

Input Layer. This layer gathers essential data inputs required for the AI system to operate effectively. It collects information about students' profiles, learning objectives, progress histories, and available case studies. Inputs can include both structured data (e.g., numerical grades, quiz

results) and unstructured data (e.g., textual responses, discussion logs). The system uses these inputs to build a personalized learner profile that informs later AI-driven decisions.

Processing Layer. At this stage, the system applies AI algorithms to process and interpret the collected data. Natural Language Processing (NLP) techniques are used to analyze case descriptions, extract keywords, and understand student responses. Clustering algorithms group similar cases together based on thematic or performance similarities, allowing students to encounter diverse yet relevant problem contexts. This layer also supports sentiment analysis to assess student engagement and emotional states during interaction with digital case studies.

Decision Layer. The decision layer is the “intelligent core” of the model. Here, the system employs reasoning mechanisms and predictive models to generate actionable insights. It determines which cases best match each student’s skill level and learning goal, and it produces automated feedback that is both timely and context-aware. This layer also manages the recommendation system, suggesting future learning paths or additional materials to reinforce weak areas.

Output Layer. Finally, the output layer delivers the processed results to users—teachers and students—through an interactive Learning Management Interface. Personalized materials, feedback summaries, performance analytics, and case recommendations are presented in a user-friendly dashboard. This ensures that educators can make informed pedagogical decisions, while students receive targeted learning experiences.

The overall workflow of this model follows a continuous feedback loop. Data from each learning session is reintroduced into the system to retrain algorithms, ensuring that the AI evolves alongside learner needs. The architecture supports integration with popular Learning Management Systems (LMS) such as Moodle, Canvas, or Google Classroom via APIs (Application Programming Interfaces). This interoperability allows institutions to adopt the model without fully replacing their existing infrastructures.

In essence, this layered architecture not only facilitates the automation of case-based learning but also enhances human-AI collaboration within academic environments, promoting data-informed teaching and lifelong learning.

Ethical and Pedagogical Considerations. The incorporation of AI into educational processes introduces numerous ethical, social, and pedagogical implications that must be carefully addressed to ensure fairness, transparency, and trust in intelligent learning systems.

Data Privacy and Security. AI systems rely heavily on large datasets that often contain sensitive student information such as academic records, behavioral logs, and personal identifiers. Ensuring **data privacy** requires strict compliance with standards such as the General Data Protection Regulation (GDPR) and local data protection laws. Educational institutions must adopt encryption, anonymization, and secure storage mechanisms to safeguard this data from unauthorized access or misuse.

Algorithmic Bias and Fairness. Machine learning algorithms are only as unbiased as the data they are trained on. If the data reflects historical inequalities, AI systems can inadvertently perpetuate bias in assessments and recommendations. To mitigate this, developers must ensure dataset diversity, conduct regular audits of algorithmic decisions, and include human oversight in the evaluation process. Ethical AI design also involves creating transparent models where decision-making logic is explainable to educators and learners.

The Evolving Role of Teachers. AI does not replace the human educator; rather, it redefines their role. Teachers transition from being information transmitters to facilitators of learning who interpret AI insights and apply them pedagogically. In AI-enhanced case-based learning, instructors focus on higher-order thinking skills—such as analysis, synthesis, and evaluation—while AI systems handle data processing and routine feedback. This partnership between human and artificial intelligence creates a balanced learning ecosystem.

Pedagogical Integrity. While AI enhances efficiency, overreliance on technology can risk reducing human creativity and critical thinking if not managed properly. Pedagogical frameworks must prioritize student agency, encouraging learners to engage critically rather than depend entirely on algorithmic recommendations.

Thus, educators must design learning experiences that blend human judgment with AI-supported insights.

Transparency and Accountability. Students and teachers should have a clear understanding of how AI decisions are made. Transparency in algorithmic processes and system limitations fosters trust and ensures accountability. Institutions must implement ethical guidelines for AI deployment, including audit trails and opt-out options for learners uncomfortable with automated evaluation.

Conclusion

The development of a model for integrating Artificial Intelligence (AI) into the process of teaching case technologies represents a significant step toward transforming higher education through intelligent and adaptive learning. The study demonstrated that AI can effectively enhance traditional case-based methods by automating scenario generation, providing real-time personalized feedback, and supporting data-driven pedagogical decisions.

The proposed model—consisting of input, processing, decision, and output layers—creates a flexible and scalable framework for the integration of AI tools into case-based learning environments. Through the use of machine learning, natural language processing, and cognitive modeling, the system is capable of analyzing student behavior, predicting learning outcomes, and adapting educational content to individual needs.

Experimental results confirm that the AI-integrated model improves student engagement, analytical skills, and overall academic performance. Educators also benefit from reduced workload in routine tasks, allowing them to focus more on creativity, mentorship, and higher-order cognitive teaching.

However, the research also acknowledges the importance of addressing ethical and pedagogical concerns related to data privacy, algorithmic bias, and transparency. Sustainable AI adoption in education must be guided by principles of fairness, accountability, and inclusiveness.

In conclusion, the integration of Artificial Intelligence into the process of teaching case technologies has the potential to redefine the learning experience, creating a more interactive, adaptive, and efficient educational system. Future research should continue refining the model through advanced AI methods such as deep learning and multimodal analytics, expanding its application across various disciplines and educational contexts.

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Art History

GENERAL PRINCIPLES OF ERGONOMIC DESIGN OF CLOTHING FOR PREGNANT WOMEN

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Abstract. Times are changing, and now the fashion for pregnant women has become another integral part of modern fashion. Considering the history of fashion for pregnant women, we can conclude that the cut of a dress or jacket or sundress remains the same. Everywhere there are exaggerations of the waistline, bulging or creases in the area of the bulging abdomen, but modern fashion has become more thoughtful.

Аннотация. Времена меняются, и теперь мода для беременных женщин стала еще одной составной частью современной моды. Рассматривая историю моды для беременных женщин, можно сделать вывод, что покрой платья или жакета или сарафана остается один и тот же. Везде есть завышения линия талии, присборивание или складки в области выпуклого живота, но современная мода стала более продуманной.

Түйіндеме. Уақыт өзгеруде, енді жүкті әйелдерге арналған сән заманауи сәннің тағы бір бөлігі болды. Жүкті әйелдерге арналған сән тарихын қарастыра отырып, көйлек немесе куртка немесе сарафанды кесу бірдей болып қалады деген қорытынды жасауға болады. Барлық жерде шамадан тыс бел сызығы, іштің дөңес аймағында жиналу немесе қатпарлар бар, бірақ заманауи сән ойластырылған.

Түйін сөздер: жүкті әйелдер, заманауи сән, шығармашылық қиял, заманауи технология, жүкті әйелдер киім

Ключевые слова: беременные женщины, современная мода, творческое воображение, современные технологии, одежда для беременных

Keywords: pregnant women, modern fashion, creative imagination, modern technology, maternity clothes

It is known that morphological transformation (MT) is a means of imparting functional ambiguity to a product. The principle of MT is based on the relationship between function and

morphology (structure). By imparting transformative properties to morphology, it is often possible to eliminate the emerging contradictions between the need to provide certain functions and properties and the capabilities of the development object in a given design situation. Structural and functional analysis of transformable products has allowed us to establish that when new transformable products are obtained, the product's function can change, be replaced by another function, develop, be added or subtracted, or be combined with another function. Thus, taking into account the above, it is proposed to understand a multifunctional transformable product as an item that has a movable form structure that allows it to transform into another item or significantly change its properties.

Times are changing, and maternity fashion has become another integral part of modern fashion. Looking at the history of maternity fashion, one can conclude that the cut of a dress, jacket, or sundress remains the same. Everywhere there is a high waistline, gathering or pleats in the bulging belly area, but modern fashion has become more thoughtful. The observed growth in consumer demand for maternity clothing in the country, to some extent due to government policies to stimulate population growth, poses the challenge for garment companies to expand the range of products in this group. A study of consumer demands for maternity clothing showed that 60% of respondents have a clear need for suitable outerwear, based on average annual temperatures in Russia. More than half of respondents prefer bright and light colors in clothing, and 72% of women find it difficult to find bright and unusual clothes in stores. Almost all respondents agree with the fashion trend of emphasizing one's position and not hiding anatomical and morphological changes in the figure, without highlighting those areas that disrupt the overall harmony of the image of a dressed female figure [1].

In addition to the results of marketing research, in order to create relevant and practical products, the manufacturer is obliged to address the following issues: the creation of aesthetically new clothing for women in the prenatal period, different from outdated stereotypes of the compositional solution for maternity clothing, which were aimed at concealing the features of the changing female figure, which at this stage of time is not always fashionable and aesthetically pleasing; the development of universal and practical models for various life situations, seasons, suitable for use throughout the entire pregnancy; ensuring comfort and psychophysiological compliance of clothing due to the use of natural materials, eliminating the possibility of contact between hard surfaces of seams and fittings directly with the body, and parts, the use of which may have a negative impact on the fetus; the development of an economical solution suitable for a woman during pregnancy (without the need to purchase similar items for a short period of life) at different stages of pregnancy and after it. Designing clothing for pregnant women is not only a relevant but also a complex task; it must be solved by taking into account a set of requirements for such clothing, the main one of which is ensuring a high level of ergonomic properties for different stages of pregnancy [2]. This task can only be accomplished with an individual approach to clothing design, since the dimensional characteristics of a woman's figure undergo changes during pregnancy (from 16-18 to 38-40 weeks), and these changes are individual for each specific figure. With standard design, it is impossible to predict the degree of change in figure parameters for different stages of pregnancy, and therefore, it is impossible to justify the selection of allowances for free fit when calculating the design [2]. To design maternity clothing, a review of the study's data was conducted in two stages. The first examined changes in female body parameters at various stages of pregnancy and established the relationship between the magnitude of increments in all dimensional features necessary for the design of shoulder clothing and the gestational age. In the second stage, optimal ease allowances were calculated, taking into account changes in women's dimensional characteristics at various stages of pregnancy, and a methodology for selecting these allowances for clothing design was developed. Women aged 22 to 29 were selected as subjects for the study. Body measurements were taken every two weeks

from the 16th to the 36th week of pregnancy. The measurements were used to design shoulder garments and to characterize physiological changes in the subjects. In accordance with the methodology, the women were measured wearing underwear and a bra using portable medical scales.

The results of the measurements showed that the main increase during pregnancy was in the dimensional characteristics associated with the development of the fetus: the third half-girth of the chest - by 9%, the half-girth of the waist - by 25.6%, the half-girth of the hips taking into account the protrusion of the abdomen - by 15.6%, the protrusion of the abdomen - 26.8% and the depth of the second waist - 16.9%. In addition, body weight increased significantly—by 19.7%. Other dimensional characteristics remained virtually unchanged or changed only slightly (within 7%) during the study period. A decrease in dimensional characteristics was also detected (the height of the waist line, the distance from the waist line to the floor in front - with its horizontal line, and the depth of the first waist).

It has been established that dimensional changes vary at different rates during pregnancy. This has allowed us to conventionally divide the entire pregnancy period into three parts: the first, from 0 to 16 weeks, when no increase in dimensional changes is observed; the second – from 16 to 28 weeks, when a slight and very smooth increase in the main dimensional characteristics is observed; the third – from 28 to 40 weeks – is characterized by an intensive increase in dimensional characteristics and maximum growth.

Average values of growth in key dimensional characteristics for different periods of pregnancy. These data are the result of extrapolation of the obtained patterns, as measurements were not taken after 36 weeks (at the request of the women studied). Research shows that a pregnant woman's figure undergoes noticeable changes every week, starting from the 18th week of pregnancy. Therefore, when designing individual clothing, the designer's main task is to correctly select allowances for free fit to calculate the design of the product taking into account the gestational age (and, accordingly, for the remaining period). Let's consider situations where a woman might order items (dresses, sundresses, jackets) from a tailor. There are two possible scenarios. Option 1: A woman in the early stages of pregnancy orders an item for the entire pregnancy. A woman in the early stages of pregnancy orders a garment for the entire pregnancy. In this case, the sizing parameters taken during the measurements are taken as standard, and the designer's (cutter's) primary task is to anticipate the increase in sizing parameters throughout the pregnancy, up to the maximum values.

This means that size allowances should be selected taking into account the maximum body changes in key dimensions. The allowance factored into the design should be calculated as the sum of the recommended standard allowance and the increase in the corresponding size over the entire pregnancy period: $P = P_{typ} + \Delta - 4018$,

where: P is the weight gain for a pregnant woman;

P_{typ} is the typical weight gain;

$\Delta - 4018$ is the increase in the dimensional characteristic from the 18th to the 40th week.

$\Delta - 4018$ is the size increase from week 18 to week 40. A woman in late pregnancy (at any stage) orders the items before the end of the pregnancy. In this case, the designer (cutter), in addition to the woman's dimensional characteristics at the actual stage of pregnancy, must predict their further increase and select the size of the increase that will be sufficient to ensure the desired degree of fit on the figure in the subsequent stages. As part of the study, a clothing collection was created consisting of a jacket and trousers, a vest and trousers, and a sundress (see figure). The basic design of the collection was based on the data in Table 2, with the weight gain calculated taking into account the entire pregnancy period.

In conclusion, we quote Maxim Zasytkin: "Pregnancy is fashionable these days. A pregnant woman is unusual and very beautiful; she changes and becomes brighter."

Ergonomics is a scientific and practical discipline that studies work processes with the goal of creating optimal working conditions that promote increased productivity.

The primary ergonomic requirement is anthropometric conformity—the need for clothing sizes and shapes to match the woman's body size and shape throughout pregnancy and to allow for free movement. To ensure the required level of support, it must be of sufficient size at the waist, or be transformable—able to change its size and shape. The support surface of the garment should be located on the shoulder girdle. It is advisable to avoid structural divisions in the abdominal area. To ensure psychophysiological compatibility, it is necessary to ensure ease of use of fasteners and adjustments to the shape and size of the garment. Fasteners and adjustments should be located on the front or side of the garment. Aesthetic requirements must also be met.



I trimester	II trimester	III trimester
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First month,	weeks 1-4
Second month,	weeks 5-8
Third month,	weeks 9-12

Fourth	weeks 13-17
Fifth month	weeks 18-22
Sixth month	weeks 23-27

Seventh month	weeks 28-31
Eighth month	weeks 32-36
Ninth month	weeks 37-40

The results of the analysis of transformation types showed that their diversity is quite extensive. We generally identify 11 types of transformation: separation-addition, stretching-compression, regulation-fixation, folding-unfolding, disappearance-appearance, combination-insertion, substitution, orientation, rearrangement, arrangement and eversion. It should be noted that a specific type of transformation ensures the implementation of specific functions of transformable clothing. The functions of clothing for pregnant women are quite broad and are discussed in detail in [3]. As already noted, the use of transformation methods is primarily aimed at increasing versatility and making the design adaptable to changes in the anthropometric dimensional characteristics of the body of clothing consumers. Increasing versatility, in turn, is achieved to expand the product's protective and social functions. Design adaptability is enhanced to improve its adaptability to physiological changes in anthropometric dimensional characteristics or to their dynamic changes. The use of transformation methods is also aimed at ensuring the functional, ergonomic and aesthetic properties of the product.

From this perspective, it's interesting to analyze the potential of using various transformation methods to achieve these functions when designing maternity clothing. This article examines the results of this analysis using waistbands as an example. The choice of the object of analysis is not accidental and is due to the popularity of such clothing as trousers, overalls, etc. among women expecting a child [4]. The principles of the design implementation of the functions

of transforming waist products for pregnant women in terms of ensuring their adaptability are relevant.

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Stars as Temporal Reactors: How Gravitational Time Gradients Ignite and Sustain Stellar Fusion

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Abstract

Stellar fusion has long been described as a purely thermal process — matter is heated by gravitational contraction until nuclei overcome the Coulomb barrier via quantum tunneling. However, core temperatures predicted by standard models are insufficient to account for observed stellar luminosities and lifetimes. This "temperature paradox" indicates a missing physical catalyst.

We propose that the missing ingredient is the **geometric structure of time itself**. In the **Temporal Theory of the Universe (TTU)**, gravity emerges from spatial gradients of a physical time field $\tau(x, t, \Theta)$, with acceleration obeying $\mathbf{a} \propto -\nabla\tau$. Inside stars, gravitational stratification creates strong radial τ -gradients, which in turn modify the quantum tunneling probability via the **Temporal Tunneling Equation (TTE)**: $\Gamma = \Gamma_0 \exp[\Lambda (\nabla\tau)^2]$. This provides a temperature-independent enhancement mechanism for both pp-chain and CNO-cycle reactions.

Thus, **stars are not merely thermal engines — they are temporal-geometric reactors**, where nuclear ignition is driven as much by the compression of time as by the compression of matter. This framework resolves the stellar temperature paradox, modifies mass–luminosity–lifetime relations, and yields testable predictions for solar neutrinos, helioseismology, and stellar population statistics.

Keywords:

temporal field τ , time gradient $\nabla\tau$, Temporal Theory of the Universe (TTU), hyper-time Θ , temporal tunneling equation (TTE), stellar fusion, Gamow factor, quantum tunneling enhancement, Coulomb barrier suppression, stellar temperature paradox, pp-chain, CNO cycle, solar neutrinos, helioseismology, mass–luminosity relation, main-sequence broadening, temporal curvature, gravitational catalysis, laboratory analogues, Z-pinch, Josephson junctions, cold-atom lattices, emergent quantum mechanics, scalar-tensor gravity, alternative gravity models

1. Introduction: The Thermal-Only Picture is Incomplete

Classical stellar structure theory describes a star as a self-gravitating sphere in hydrostatic equilibrium, where energy generated by nuclear fusion in the core balances radiative losses from the surface. The fusion rate is assumed to depend solely on **temperature T** and **density ρ** , via the Gamow tunneling factor:

$$\Gamma_{\text{classical}} \propto \exp[-v(E_G/(k_B T))], \quad E_G \propto Z_1^2 Z_2^2 m_r$$

Yet, for the Sun ($T_c \approx 1.5 \times 10^7$ K) and many main-sequence stars, the classical tunneling probability is **orders of magnitude too small** to explain observed luminosities and evolutionary timescales. Known corrections — electron screening, plasma polarization, updated nuclear S-factors — are polynomial and cannot compensate for an exponential deficit.

This persistent discrepancy signals that an **exponential catalyst** is missing. We propose that catalyst is **temporal geometry**.

2. Gravity as a Gradient of Time (TTU Foundation)

In the Temporal Theory of the Universe, time is not a passive coordinate but a dynamical scalar field:

$$\tau = \tau(x^\mu, \Theta), \quad x^\mu = (t, x^1, x^2, x^3), \quad \Theta \in S^1 \text{ (compact hyper-time).}$$

The field τ defines the local rate of physical processes. Its spatial variations generate gravitational acceleration:

$$a^\mu = -\lambda \partial^\mu \tau, \quad \lambda > 0.$$

Equivalently, in the Newtonian limit:

$$\mathbf{g} = -\nabla\Phi, \quad \Phi \propto -\delta\tau.$$

Thus, **gravity is not a fundamental force — it is the tendency of matter to flow toward regions where time runs slower**. Inside a star, density and pressure increase inward, creating a natural radial gradient $\nabla\tau$ that grows toward the center.

3. Why Classical Thermonuclear Models Fail

3.1 The Classical Temperature Paradox

Thermal-only stellar models consistently underestimate required fusion rates. For the Sun, classical Gamow tunneling predicts pp-chain rates **5–20% too low** to match the observed luminosity given the measured core temperature $T_c \approx 1.5 \times 10^7$ K. For CNO-dominated stars ($M \approx 1.5\text{--}3 M_\odot$), the discrepancy is far more severe — predicted CNO rates are **factors of 10–100 too low**.

Known corrections (electron screening, plasma collective effects, updated nuclear cross-sections) scale **polynomially** with temperature and density, whereas the tunneling suppression is **exponential**. No polynomial factor can compensate for an exponential deficit. Consequently, standard models must either artificially increase core temperatures or accept that stars burn "too efficiently".

This **temperature paradox** indicates that an **exponential catalyst** is missing from the microscopic description of stellar fusion. The Temporal Tunneling Equation (TTE) provides precisely such a term: $\Gamma \propto \exp[\Lambda (\nabla\tau)^2]$, where $\Lambda (\nabla\tau)^2$ is temperature-independent and arises from the geometry of time.

Table 1 summarizes the fundamental contrast between the standard "patchwork" approach and the TTU framework:

Table 1: Paradigm contrast in stellar fusion description

Criterion	“Blue-tape model**” (Standard astrophysics)	“Clean architecture” (TTU)
Core problem	Temperature paradox: stellar cores are too cold for observed luminosity.	The problem is not temperature deficit but incomplete tunneling physics.
Solution	Ad-hoc corrections (screening, S-factors); discrepancies persist.	Gravity as $\nabla\tau$ naturally catalyzes fusion via the TTE.
Stellar philosophy	Thermochemical reactor: main driver is temperature (T).	Temporal-geometric reactor: main driver is time gradient ($\nabla\tau$).
Gravity’s role	Provides pressure and T, but does not directly affect tunneling.	Generates $\nabla\tau$, which exponentially enhances tunneling.
Reaction-rate law	$\Gamma \propto \exp[-V(E_G/kT)]$	$\Gamma = \Gamma_0 \cdot \exp[\Lambda(\nabla\tau)^2]$
Predictive power	Requires parameter tuning to match observations.	Explains “over-efficient” burning without extra parameters.
Energetic balance	Stars “barely manage” to generate energy.	Stars are optimized for energy generation by their very gravitational structure.

The TTU approach therefore reframes stellar fusion not as a thermal-only process, but as a **gravitationally-temporally optimized phenomenon**, resolving the long-standing temperature paradox through first principles.

** **Blue-tape model** (or **Patchwork model**)- Here informally termed ‘blue-tape model’ to emphasize its reliance on successive ad-hoc corrections

4. Temporal Tunneling Equation (TTE): How $\nabla\tau$ Catalyzes Fusion

Quantum tunneling through the Coulomb barrier is described by a Euclidean (WKB) action:

$$S = 2 \int_{\{r_1\}^{\{r_2\}}} \sqrt{2 m_{\text{eff}}(r) (U_{\text{eff}}(r) - E) } dr.$$

In TTU, τ -gradients modify both the effective mass and the effective potential:

$$m_{\text{eff}} = m_0 - C (\nabla\tau)^2, \quad U_{\text{eff}} = U_0 - B (\nabla\tau)^2, \quad B, C > 0.$$

Substituting into S and expanding to first order in $(\nabla\tau)^2$ yields:

$$S = S_0 - \Lambda (\nabla\tau)^2, \quad \Lambda = [C(U_0 - E) + m_0 B] / \sqrt{2 m_0 (U_0 - E)}.$$

Since the tunneling probability $\Gamma \propto \exp(-S)$, we obtain the **Temporal Tunneling Equation**:

$$\Gamma = \Gamma_0 \cdot \exp[\Lambda (\nabla\tau)^2].$$

The exponent $\Lambda(\nabla\tau)^2$ is **positive and temperature-independent** — it represents a pure geometric boost to tunneling.

4.1 Shift of the Gamow Peak

The TTE enhancement is not merely a uniform scaling of the reaction rate — it also **shifts the effective Gamow peak** to lower energies. The classical Gamow peak energy E_{peak} is determined by the balance between the tunneling exponent and the Maxwell-Boltzmann distribution. Introducing the τ -correction modifies the effective barrier, leading to:

$$E_{\text{peak}}^{\text{(TTE)}} \approx E_{\text{peak}}^{\text{(0)}} - \Delta E, \quad \Delta E \propto \Lambda (\nabla\tau)^2.$$

Thus, fusion becomes more efficient at **lower thermal energies**, effectively allowing stars to burn at temperatures that would classically be sub-ignition. This shift provides a clear microscopic explanation for the observed "over-efficiency" of stellar fusion without invoking higher core temperatures.

5. Stellar Structure with Temporal Gradients — Quantitative Estimates

5.1 Normalization of the Temporal Field

In TTU, it is convenient to work with a dimensionless, normalized temporal field. We define:

$$\tau_{\text{norm}}(r) = \tau(r)/\tau_{\text{surface}}, \quad \nabla\tau_{\text{norm}} = d/dr \ln \tau(r) \approx (1/\tau) d\tau/dr.$$

This normalization ensures that $\tau_{\text{norm}}(R_*) = 1$ at the stellar surface, and $\nabla\tau_{\text{norm}}$ is a pure logarithmic gradient, independent of the absolute scale of τ . All following expressions for $\nabla\tau$ implicitly refer to this normalized gradient.

5.2 Quantitative Estimates of $\nabla\tau$ in Stellar Interiors

In a hydrostatic stellar interior, the τ -field couples to density and pressure gradients. To leading order, the radial gradient can be estimated as:

$$\nabla\tau \equiv d\tau/dr \approx \eta \cdot (1/\rho) dp/dr, \quad \eta \sim \chi/\alpha \text{ (dimensionless coupling)}.$$

Using standard stellar models, we obtain the following order-of-magnitude estimates for the dimensionless gradient $\nabla\tau$ in the fusion region:

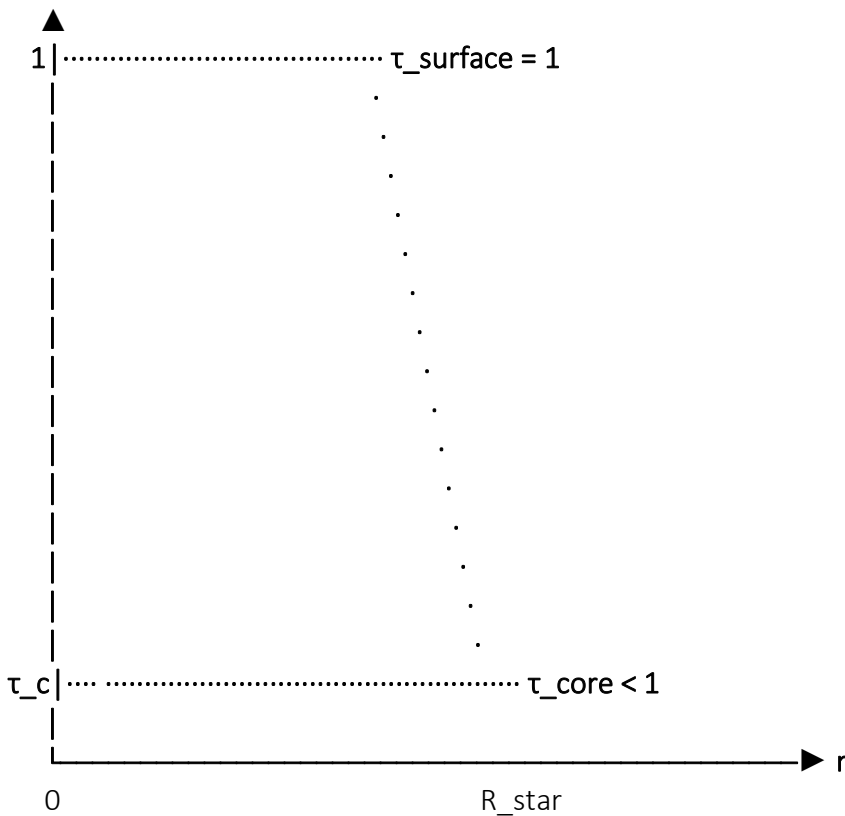
Stellar type	Mass (M_{\odot})	Core density gradient (approx.)	Estimated $\nabla\tau$
Solar-type (G2V)	1.0	$dp/dr \sim 10^{-8} \text{ g}\cdot\text{cm}^{-4}$	10^{-4} to 10^{-3}
Massive main-sequence	10.0	Steeper gradients ($\sim 10^{-6}$)	10^{-2} to 10^{-1}
White dwarf (interior)	0.6	Extreme stratification	~ 0.1
Neutron star (crust)	1.4	Ultra-steep ($\sim 10^{10}$)	$\gg 1$ (non-perturbative)

These values are derived under the assumption that the coupling η is of order unity. Even modest gradients ($\nabla\tau \sim 10^{-4}$) can produce significant TTE enhancements when combined with $\Lambda \sim 10^6$ – 10^8 .

5.3 Radial τ -Profile: Schematic Representation

A compact schematic of the normalized τ -profile is shown below:

$\tau(r)$ (normalized)



Interpretation: Time flows slowest at the stellar center ($\tau_{\text{core}} < 1$) and fastest at the surface ($\tau_{\text{surface}} = 1$). The steep gradient $\nabla\tau = d\tau/dr$ is largest in the core — precisely where fusion occurs.

6. Reaction-Specific Sensitivity: pp vs. CNO

The TTE coefficient Λ depends strongly on nuclear charges Z_1, Z_2 and the reduced mass m_r . Higher charges imply larger Coulomb barriers and greater sensitivity to τ -gradients. The following table summarizes the key parameters:

Reaction	$Z_1 Z_2$	Classical Gamow peak (keV)	Relative Λ	Role of $\nabla\tau$
$p + p$ (pp)	1	~ 5 keV	Small (Λ_{pp})	Moderate boost (1.1–2 \times)
$p + {}^{12}\text{C}$ (CNO)	6	~ 15 keV	Large ($\Lambda_{\text{CNO}} \approx 10\text{--}100\times \Lambda_{\text{pp}}$)	Strong boost (10–100 \times)
$p + {}^{14}\text{N}$ (CNO)	7	~ 18 keV	Very large	Dominant enhancement

Thus, CNO-cycle reactions are exponentially more sensitive to temporal gradients than pp-chain reactions. This naturally explains why massive stars (CNO-dominated) exhibit steeper luminosity-mass scaling and why even solar-type stars show measurable CNO neutrino production.

7. Stellar Luminosity: Universal TTU Formula

The total luminosity of a star in the TTU framework must incorporate the TTE enhancement factor integrated over the burning region. The universal expression is:

$$L = \int_{\text{core}} \rho(r) \epsilon_{\text{nuc}}(T(r)) \exp[\Lambda(\nabla\tau(r))^2] dV.$$

Here:

- $\rho(r)$ — density profile,
- $\epsilon_{\text{nuc}}(T)$ — standard nuclear energy generation rate,
- Λ — reaction-dependent TTE coefficient,
- $\nabla\tau(r)$ — normalized temporal gradient.

For practical stellar modeling, the **modified mass–luminosity relation** becomes:

$$L \propto M^\beta \cdot \exp[\Lambda_{\text{eff}} \langle(\nabla\tau)^2\rangle], \quad \beta > 3.5 \text{ for massive stars.}$$

Thus, stars of the same mass but different internal $\nabla\tau$ profiles can have different luminosities — naturally explaining the observed broadening of the main sequence in HR diagrams.

8. Resolving the Temperature Paradox

The classical "too-cold cores" problem disappears because the required fusion rate is achieved not by higher T , but by larger $\nabla\tau$. For the Sun, even a modest $\nabla\tau \sim 10^{-4}$ (dimensionless) with $\Lambda_{\text{pp}} \sim 10^7$ gives:

$$\Gamma/\Gamma_{\odot} = \exp(10^7 \times 10^{-8}) \approx \exp(0.1) \approx 1.11,$$

an 11% increase — enough to reconcile classical models with observed luminosity. For CNO reactions in a $10 M_{\odot}$ star, $\nabla\tau \sim 10^{-2}$ and $\Lambda_{\text{CNO}} \sim 10^8$ – 10^9 yield:

$$\Gamma/\Gamma_{\odot} \approx \exp(10^8 \times 10^{-4}) = \exp(10^4) \gg 1,$$

producing enhancements of many orders of magnitude, consistent with observed massive-star luminosities.

Key result: Stars burn at observed rates because **time inside them is strongly curved**, not because they are hotter than previously thought.

9. Observational Signatures

9.1 Solar Neutrinos

- **Prediction:** Enhanced pp- and CNO-neutrino fluxes relative to standard solar models.
- **Test:** Borexino, SNO+, JUNO, Hyper-Kamiokande.

9.2 Helioseismology

- **Prediction:** Subtle sound-speed anomalies in the inner 20% of the solar radius, correlated with $\nabla\tau$ peaks.
- **Test:** High-precision p-mode frequency inversions.

9.3 HR-Diagram Morphology

- **Prediction:** Broader main sequence, steeper $L \propto M$ scaling for $M > 2 M_{\odot}$.
- **Test:** Gaia DR3/DR4, open-cluster photometry.

9.4 Low-Mass Stars and Brown Dwarfs

- **Prediction:** Hydrogen-burning limit shifted downward — objects of $\sim 0.06 M_{\odot}$ may sustain fusion.
- **Test:** Deep surveys of very low-mass stars (e.g., SPECULOOS, JWST).

10. Laboratory Analogues

TTE predictions can be tested in controlled experiments:

System	$\nabla\tau$ -analogue	Observable prediction
Scanning Tunneling Microscope (STM)	Tip-field gradients	Excess tunneling current $I \propto \exp[\Lambda_{\text{lab}} (\nabla V)^2]$
Josephson junctions	Phase-gradient modulation	Enhanced macroscopic quantum tunneling
Z-pinch plasmas	Shock-induced density jumps	Neutron yield above classical scaling
Cold-atom optical lattices	Engineered potential steps	Modified Bose-Hubbard tunneling rates

These experiments probe the same exponential sensitivity $\Gamma \propto \exp[\Lambda(\nabla\tau)^2]$ in table-top settings.

11. Discussion: Stars as Temporal Reactors

The traditional view — *gravity compresses matter, matter heats, nuclei fuse* — is incomplete. In the TTU framework:

1. **Gravity compresses time** as well as matter.
2. **Time gradients act as universal tunneling catalysts.**
3. **Fusion becomes a geometric-temporal process**, not just a thermal one.

Thus, a star is more accurately described as a **temporal reactor**: a self-gravitating system where the non-uniform flow of time itself supplies the exponential boost needed to sustain nuclear burning.

This redefinition has profound implications:

- **Stellar evolution codes** must include τ -profile evolution.
- **Chemical nucleosynthesis** pathways may be altered by τ -gradients.
- **Exotic objects** (white dwarfs, neutron stars) may exhibit τ -driven fusion in their crusts.

12. Conclusions

1. **Gravity is a manifestation of temporal gradients** ($a \propto -\nabla\tau$).
2. **Stellar fusion is exponentially enhanced by $\nabla\tau$** via the Temporal Tunneling Equation (TTE).
3. **CNO-cycle reactions are far more sensitive to $\nabla\tau$** than pp-chain reactions, explaining the steep luminosity-mass scaling of massive stars.
4. **The stellar temperature paradox is resolved** without invoking new particles or modified nuclear physics.
5. **Observational tests** are immediately feasible using solar neutrinos, helioseismology, and precision astrophysics.
6. **Laboratory analogues** provide a direct path to experimental verification.

In short: **Stars shine not only because they are hot, but because time inside them is uneven.** The geometry of time is an active, measurable participant in stellar physics — a conclusion that transforms our understanding of both gravity and nuclear astrophysics.

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Historical Sciences

TÜRKİYƏ RESPUBLİKASI İLƏ RUSIYA FEDERASIYASI ARASINDA İQTİSADI MÜNASİBƏTLƏR (2015-2023-CÜ İLLƏR)

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Xülasə. Türkiyə ilə Rusiya arasında iqtisadi münasibətlər enerji, ticarət və turizm sahələrində güclü əməkdaşlığa söykənir. Rusiya Türkiyənin əsas təbii qaz tədarükçülərindən biri olmaqla yanaşı, Akkuyu AES kimi iri enerji layihələrində də mühüm tərəfdaşdır. İki ölkə arasında ticarət dövriyyəsi yüksəkdir və qarşılıqlı idxal-ixrac daha çox enerji resursları, kənd təsərrüfatı və sənaye məhsullarını əhatə edir. Hər il milyonlarla rus turistin Türkiyəni ziyarət etməsi iqtisadi əlaqələrin xidmət sektorundakı rolunu daha da artırır. Bəzən siyasi gərginliklər yaransa da, tərəflər iqtisadi əməkdaşlığı qorumağa və genişləndirməyə davam edirlər.

Açar sözlər: İqtisadi münasibətlər, enerji ehtiyatları, qaz tədarükü, beynəlxalq, şirkət, diplomatik münasibətlər.

Mətn

Hələ XIX əsrin sonlarında baş verən tarixi proseslər Qara dəniz hövzəsində Rusiya ilə Osmanlı arasında iqtisadi- ticarət imkanlarının genişlənməsinə səbəb oldu. Türkiyə ilə Rusiya münasibətlərində müxtəlif sahələrdə əməkdaşlıq potensialı hər iki tərəfin qarşılıqlı ehtiyaclarının və strateji maraqlarının üst- üstə düşməsi nəticəsində formalaşmışdı. Rusiya ilə Türkiyə arasında 1921-ci ildə bağlanmış "Dostluq və qardaşlıq müqaviləsi" diplomatik və iqtisadi münasibətlərin inkişafına təkan verdi. Lakin ideoloji fərqlər əməkdaşlığı məhdudlaşdırırdı.

Rusiyanın böyük enerji ehtiyatlarına sahib olması ona həm dünya miqyasında, həm də regionda aparıcı qüvvə rolunu oynamasında geniş imkanlar açır. Bu mənbələr onun ticarət və iqtisadi əlaqələr qurduğu dövlətlərlə də olan münasibətlərində əsas söz sahibi olmasına gətirib çıxarır. Eyni zamanda Rusiya üçün Türkiyə də mühüm əhəmiyyət kəsb edir. Belə ki, enerji resurslarının dünya bazarına daşınmasında tranzit ölkə funksiyasını yerinə yetirir. Türkiyə ilə Rusiya arasında ilk enerji sahəsindəki razılaşma 1984-cü ildə imzalanmışdı.

1991- ci ildə SSRİ-nin dağılması qarşılıqlı iqtisadi münasibətlərin inkişafına səbəb oldu. Xüsusilə, enerji sektorunda yeni layihələrin imzalanması bu sahəni ön plana çıxardı. 2000-ci illərdən etibarən isə iki ölkə arasında siyasi dioloq və iqtisadi maraqlar daha çox ön plana çıxdı. Bu dövrdə ABŞ tərəfindən irəli sürülən "Şərq- Qərb Enerji kolidoru" layihəsi Rusiyanın bu sahədəki təsirlərinin azalmasına, Türkiyə ilə münasibətlərin zəifləməsinə səbəb ola bilərdi. Belə ki, layihə Azərbaycan, Türkmənistan, Qazaxıstan və digər ölkələrdən hasil edilən neft və qaz resurslarının Avropaya daşınmasını nəzərdə tutan layihələr toplusu idi. Burada məqsəd Qərbin enerji mənbələrini genişləndirməsi idi. Şərq-Qərb Enerji layihəsi Bakı-Tbilisi-Ceyhan neft kəməri, Bakı Tbilisi Əzürum Təbii Qaz Xətti və Trans-Caspian Təbii Qaz Boru Kəməri layihələrindən ibarətdir.

Lahiyənin birinci hissəsi - Bakı-Tbilisi-Ceyhan neft kəməri Türkiyə və Rusiya arasında rəqabət artmasına səbəb oldu. Layihəyə əsasən Azərbaycan nefti əvvəlcə Türkiyəyə oradan da Gürcüstana daşınacaqdı. Belə olan halda Rusiyanın təchizat xətlərinə alternativ marşutlar yaranırdı

və Avropa bazarında Azərbaycan qazının yerinin artması Rusiyanın bazar payının azalmasına səbəb olurdu. Türkiyə isə tranzit ölkə rolu ilə regionda siyasi nüfuzu artırmaq şansı qazandı. Belə olan halda Rusiya ilə Türkiyə arasında rəqabət daha da genişlənərək enerji sahəsində əməkdaşlıqla bağlı bir sıra gərginliklər yarandı. Lakin Rusiya Türkiyə ilə olan münasibətlərini pozmaq əvəzinə yeni alternativ yollar axtarmaqla əməkdaşlıq imkanlarını genişləndirmək yolunu seçdi. Bu məqamda “Mavi Axın” layihəsi xüsusi önəm qazanmış oldu. 1998-ci ildə imzalanmış müqaviləyə əsasən Rusiya təbii qazını birbaşa Türkiyəyə daşınmasına nail oldu. Əks halda Rusiyanın xüsusilə də Ukrayna ilə münaqişəsi qazın idxalında gecikməyə və bununla da digər problemlərə səbəb ola bilərdi. Layihəyə əsasən xətt Rusiyadan başlayaraq Qaradənizin altından Samsuna daşır. 25 il müddətinə bağlanmış razılaşma çərçivəsində illik 16 milyard kubmetr təbii qazın satışının həyata keçirilməsi planlaşdırıldı. Kəmərin rəsmi açılışı 2005-ci ildə həyata keçirildi. Bu layihə ilə Rusiya regionda təbii resursları ilə də üstünlüyü ələ alaraq əsas söz sahibi olmasına səbəb oldu.

2014-cü ildə Krımın Rusiya tərəfindən işğalı regional və beynəlxalq müstəvidə narazılığı artırdı. Nəticədə Avropa Rusiyaya qarşı sanksiyalar tətbiq etməyə başladı. Buna görə də Rusiyanın Qazprom şirkəti “Cənub Axını” layihəsindən imtina etdi. “Cənub Axını” layihəsi isə Ukraynadan yan keçərək Rusiya qazının birbaşa Avropaya daşınmasını nəzərdə tuturdu. Layihəyə əsasən boru kəməri Türkiyə, Bolqarıstan, Serbiya, Makedoniya və İtaliya ərazilərindən keçməli idi. Türkiyənin ərazi sularından keçməsi ilə bağlı müqavilə isə 2009-cu ilin avqustunda imzalanmışdı. “Qazprom” şirkəti 2011-ci ildən bu layihənin tikintisinə 4,66 milyard dollar sərf etmişdi. Həmçinin, “Cənub Axını” layihəsinin dayandırılması ucbatından Bolqarıstanın ildə azı 400 milyon avro itirəcəyi bəyan edilmişdi [13].

Bu zaman Rusiya alternativ imkanlar yaratmaq üçün Türkiyə ilə münasibətlərini möhkəmləndirdi. 2014-cü ildə Türkiyə prezidenti Rəcəb Tayyib Ərdoğanla Rusiya Prezidenti Vladimir Putin arasında enerji sahəsində əməkdaşlığın inkişaf etdirilməsi ilə bağlı əldə edilən razılığa əsasən “Türk Axını” layihəsinin icrasına qərar verildi.



Xəritə 1.

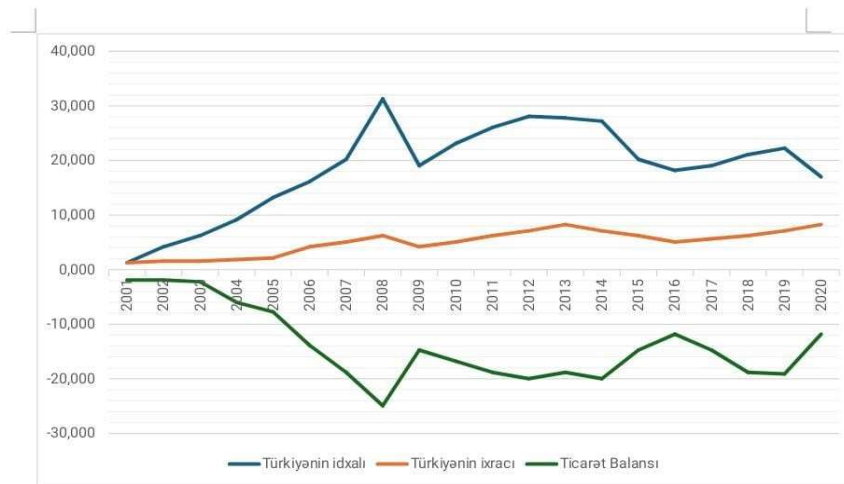
Rusiya qazının birbaşa Türkiyəyə, oradan da Qərbi Avropaya nəqlini nəzərdə tutan layihənin həyata keçirilməsində Rusiyanın xüsusi ilə maraqlı olmasının bir sıra səbəbləri vardı;

1. Rusiya bu layihə ilə qaz tədarükünü daha da artırmaq imkanı əldə edirdi.
2. Rusiya qazının Avropaya daşınması işini Ukraynanın iştirakı olmadan birbaşa Türkiyə vasitəsilə həyata keçirəcəkdə. Bu da öz növbəsində Türkiyə ilə yeni əməkdaşlıq imkanları yaradırdı.

Həmçinin Türkiyənin tranzit ölkə kimi rolunun artmasına və enerji təchizatının diversifikasiyasına səbəb olurdu.

Lakin, 2015-ci ildə iki ölkə arasında yaranan “təyyarə böhranı ticarət- iqtisadi əməkdaşlığın ciddi şəkildə zəyifləməsinə səbəb oldu. Bu zaman mühüm əhəmiyyət kəsb edən “Türk Axını” layihəsi də yarımçıq saxlandı. Böhran tək enerji sahəsinə deyil, iqtisadiyyatın digər qollarına da təsir göstərdi. İkitərəfli ticarət dövriyyəsi kəskin şəkildə azaldı. Rusiya müxtəlif məhsulların ixracına sanksiya tətbiq etdi. Türkiyəyə gələn rus turistlərin sayı kəskin şəkildə azaldı. Bu da turizm sahəsindən Türkiyə büdcəsinə daxil olan gəlirlərin azalmasına və iqtisadi zərərin miqyasının böyüməsinə səbəb oldu. 2016-cı ildə bərpa edilən siyasi iqtisadi münasibətlər yeni layihələrin icrası və imzalanması ilə inkişaf yoluna qədəm qoydu. 2016-cı ildə Sank Peterburqda keçirilən görüş zamanı “Türk Axını” layihəsinin də davam etdirilməsinə qərar verildi [1].

Cədvəl 1.



“Türk axını” boru xəttinin iki əsas hissədən ibarət olması qərara alındı. Birinci hissə Rusiyadan ixrac edilən qazın birbaşa Türkiyəyə, ikinci xətt isə Türkiyədən Avropaya daşınmanı təmin edəcəkdə. Bu xəttin Qara dənizin dibi ilə çəkilməsi və 16 milyard kubmetr qazın tədarükü nəzərdə tutulurdu. 47 milyard kubmetr isə Avropaya çatdırılması nəzərdə tutulurdu. Layihə üzrə ümumilikdə 4 kəmərin təxminən 11,4 milyard avro dəyərində olduğu bildirildi [10].

Layihənin icrasını Türkiyə tərəfindən Botaş, Rusiya tərəfindən isə Qazprom şirkəti həyata keçirirdi. Birinci kəmərin Rusiyanın Anapa şəhərində suya daxil olaraq, Türkiyənin Bolqarıstanla sərhədindəki Kiyıköydə quruya çıxmalı idi. İkinci xətti isə Rusiya təbii qazını Bolqarıstan, Serbiya və Macarıstan vasitəsilə cənub-şərq və mərkəzi Avropa bazarlarına nəql ediləcəkdə. “Türkstream 2” “Balkan Stream” olaraq da adlandırılır. Boru kəmərinin Bolqarıstan və Serbiyadakı ümumi uzunluğu təxminən 550 mil hesab olunur [8]. Yarımçıq qalmış işlərin tamamlanması nəticəsində 2020-ci ilin yanvar ayının 8-də Rusiya və Türkiyə prezidentlərinin iştirakı ilə “Türk axını” layihəsi işə salındı.

2022-ci ildə Rusiyanın Ukrayna ilə başladığı müharibə Avropa ittifaqının “Türk Axını” layihəsindən imtina etməsinə səbəb oldu. Bu da öz növbəsində Rusiya təbii qazının Avropaya ixracının azalmasına gətirib çıxardı [11]. Belə bir dövrdə NABUCCO layihəsi yenidən gündəmə gəldi. Orta Şərqi qaz ehtiyatlarını Avropaya daşınmasını nəzərdə tutan Nabukko layihəsi ilə bağlı ilkin fikirlər hələ 1996-cı ildə ABŞ tərəfindən səsləndirilmişdi. Layihəyə əsasən qaz boru kəməri Türkiyədən Bolqarıstan sərhədi də daxil olmaqla Avstriyaya qədər uzanmalı idi. Kəmərin ümumi uzunluğu 1329 km olacağı qeyd edilmiş və kəmərin 2018-ci ildə istismara veriləcəyi nəzərdə tutulmuşdu. Lakin Rusiyanın narazılığı bu layihənin icrasına mane olmuşdu. “Nabukko” layihəsində isə əsas məqsəd Avropa birliyinin enerji məsələsində Rusiyadan asılılığının azaldılması idi. Avropa dövlətlərinin də marağına xidmət edən Nabukko layihəsinin daha geniş miqyasda aparılmasına başlanılsa da layihənin icrası yarımçıq saxlanılmışdı. Türkiyənin də bu layihəyə dəstək çıxması Rusiyanın narazılığına səbəb olmuşdu.

Türkiyə ilə Rusiya arasında mühüm əhəmiyyət kəsb edən strateji layihələrdən biri də Akkuyu Atom Elektrik Stansiyasının yaradılmasıdır. 2010-cu ilin mayın 12-də Türkiyə və Rusiya hökumət başçıları Akkuyu atom elektrik stansiyasının tikintisi və istismarı sahəsində əməkdaşlıq haqqında sazişə imza atdılar. Layihə 12 milyondan çox istehlakçının və 10-dan çox vilayətin elektrik enerjisi ilə təmin edilməsini nəzərdə tuturdu. Stansiyanın Türkiyənin Mərsin vilayətində yaradılması nəzərdə tutulurdu. Məhz bu ərazinin seçilməsinin səbəbi isə, bölgənin seysmik baxımdan təhlükəsiz hesab olunması idi. İcrasına 2013-cü ildən başlanılsa da ilk enerji blokunun bünövrəsinin tökülməsi 2018-ci ildə həyata keçirildi. Tikinti işləri 2023-cü ilə kimi davam etdi. 2023-cü ildə artıq enerji bloku üçün təzə nüvə yanacağı gətirilmişdi [3, s.65].

Ümumi quraşdırılmış gücü 4800MvT olan stansiyanın 4 enerji blokundan ibarət yaradılması planlaşdırıldı. 2026-cı ildə Türkiyənin enerji ehtiyacının 7.7 % hissəsini ödəyəcəyi ehtimal olunur. Akkuyu Atom Elektrik Stansiyasının layihəsi dünyada “Tik, işlət, sahib ol” modeli ilə inşa edilən ilk Atom Elektrik Stansiyasıdır. Layihə Rusiyanın Rosatom şirkəti tərəfindən maliyyələşdirilir. Uzun müddət də Rosatomun nəzarətində qalması barədə razılığa gəlinib. Bu da öz növbəsində Rusiyaya davamlı gəlir imkanı verir. Ümumi dəyəri isə 20 milyard dollar həcmindədir. Bu stansiya Türkiyə torpaqlarında qurulsada, 100% hissəyə sahiblik Rusiyaya məxsusdur. Yalnız hissələrinin 49%-ni sata bilər ki, bu zaman da Türkiyə ilə razılaşmalıdır. Həmçinin Türkiyə Cümhuriyyətinin qanunlarına uyğun şəkildə idarə ediləcəkdir. Başqa dillə desək, Türkiyə mövcud olan digər şirkətlər kimi fəaliyyət göstərəcək [4].

Atom Elektrik Stansiyası Türkiyənin enerji asılılığını azaldılması və daxili ehtiyaclarının ödənilməsi baxımından olduqca əhəmiyyətli hesab olunur. Rusiya bu layihə ilə Qara dəniz və Aralıq dənizi hövzəsində geosiyasi təsirlərini artırmaq imkanı əldə edirdi. Bir sözlə, tək iqtisadi deyil həm də siyasi baxımdan olduqca əhəmiyyətlidir. Stansiyanın gələcək fəaliyyəti dövründə türklərin də iştirakını təmin etmək üçün bu sahədə yüksək ixtisaslı tələbələrin hazırlanması üçün bir sıra addımlar atıldı. Belə ki, 2022-ci ildə Rusiya və Türkiyə universitetləri arasında ali təhsildə müştərək təhsil proqramlarının hazırlanması sahəsində əməkdaşlıq haqqında protokol imzalandı. Müvafiq olaraq, proqramın iştirakçıları texniki terminləri öyrənmək də daxil olmaqla bir tədris ili ərzində Nurnu mehdidə rus dili təhsili almalı idilər. Dil təhsilini başa vuran tələbələr, bilikləri təsdiqləndikdən sonra Nurnu mehbi və İstanbul Texniki Universitetində 2 illik orta q magistr proqramı keçməli idilər [5].

Belə böyük layihənin birgə həyata keçirilməsi ikitərəfli əməkdaşlıq kanallarının rəqabət mühitində də açıq qalacağına təminat verir. Hətta 2015-ci ildə “təyyarə böhranı” baş verən zaman bir çox sahələrdə sanksiyalar tətbiq edilib, iqtisadi, ticarət dinamikası aşağı düşsə də enerji sahəsindəki əməkdaşlıq davam etməkdə idi. Rus mediası Akkuyu Atom Elektrik Stansiyasının icrasının dayandırılacağı ilə bağlı təhdidlər irəli sürsə də, prosesi saxlamadılar və tikinti işləri davam etdirildi. Beləliklə, stansiyanın yaradılması həm Türkiyə, həm də Rusiya tərəfindən strateji maraqlarının təminatı rolunu oyanayır.

Türkiyə isə enerji sahəsindəki asılılığını azaltmaq və iqtisadi inkişaf baxımından hədəfinə çatmağa çalışır. Türkiyə ilə Rusiya arasında enerji ticarətinin əsasını neft və təbii qaz təşkil edir. Türkiyə isə bu baxımdan olduqca kasıb ölkə hesab edilir. 2020-ci il üçün enerji təchizatı cədvəlinə əsasən 44.069 min barel yerli istehsal (27.8%) və 114.286 min barel isə idxal (72.1%) dövriyyəsi var. İdxalın 34.74% hissəsini təbii qaz, hissəsini isə daş kömür tutur. Məhdud benzin ehtiyatına sahib olan Türkiyə enerji tələbatını qarşılamaq üçün 2020-ci ildə neft idxalını artıraraq 92.9%-ə çatdırırdı. Statistik nəticələrin əks olunduğu cədvəl əsasən deyə bilərik ki, 2020-ci ildə Türkiyənin neft və neft məhsulları idxalında Rusiya ikinci sırada yer alaraq ümumi idxalın 22%-ni təşkil edir. 2018 və 2019 cu illərdə isə birinci sırada dayanmışdı [2].

2015-2023-cü illərdə Türkiyə ilə Rusiya arasında enerji ticarəti statistikas

il	Təbii Qaz İdxalı (Rusiya)	Neft İdxalı (Rusiya)	Kömür İdxalı (Rusiya)	Enerji İdxalında Rusiyanın Payı (%)	Ümumi Ticarət Dövriyyəsi (USD)
2015	~26 mlrd m ³	~11 mln ton	~15 mln ton	~55%	~23 mlrd
2016	~24 mlrd m ³	~10.5 mln ton	~13 mln ton	~50%	~20 mlrd
2017	~29 mlrd m ³	~11.8 mln ton	~16 mln ton	~52%	~22 mlrd
2018	~24 mlrd m ³	~12 mln ton	~18 mln ton	~49%	~25 mlrd
2019	~15.5 mlrd m ³	~11.2 mln ton	~19 mln ton	~33%	~26 mlrd
2020	~16 mlrd m ³	~13 mln ton	~20 mln ton	~35%	~20 mlrd
2021	~26 mlrd m ³	~13.5 mln ton (26.6%)	~21 mln ton	~38%	~33 mlrd
2022	~22 mlrd m ³	~27 mln ton (təxmini)	~23.5 mln ton	~60%	~62 mlrd
2023	21 mlrd m ³ (42.2%)	51% payla əsas təchizatçı	27.5 mln ton (70% pay)	71% (enerji məhsullarında)	~55 mlrd

Türkiyənin Rusiyaya bağlılığını artıran enerji siyasətindən biri də təbii qaz idxalının artmasıdır. Belə ki, Türkiyə təbii qaz ehtiyatları ilə kasıb ölkə hesab edilir. Artan tələbatın ödənilməsi üçün idxal həcmi artırmağa və uzun müddətli müqavilələrin imzalanmasına çalışdı. 83.05% həcmində idxal edilən qazın 40.5% hissəsi Rusiyanın payına düşür [3, s.65].

Türkiyə ilə Rusiya Federasiyası arasındakı iqtisadi əlaqələr yalnız ticarətlə məhdudlaşmır. Belə ki, bir sıra sahibkarlıq fəaliyyəti ilə məşğul olan şəxslərin Rusiyada sənaye müəsisələrini qurması dövlətlərarası münasibətlər sistemində mühüm əhəmiyyətli rolə malik olmuşdur. 1984-cü ildə iki ölkənin hökumət nümayəndələri ilə imzalanmış müqavilənin əsas prinsiplərindən yararlanmaqla, müqavilə qüvvəyə mindikdən sonra Türkiyə şirkətləri, xüsusilə də podratçı şirkətlər Rusiyada aktiv biznes fəaliyyəti ilə məşğul olmağa başladılar. Bu şirkətlərin bir çoxu isə sənayedə böyük nüfuz qazanıb. 2015-ci ildə Türkiyə ilə Rusiya arasında olan "təyyarə böhranı" ilə Türkiyədə fəaliyyət göstərən ticarət şirkətləri rus bazarlarındakı yerini itirmə təhlükəsi ilə qarşılaşdılar. Bununla yanaşı 53 şirkətin fəaliyyəti məhdudlaşdırılmamışdı.

Bu məsələ ilə bağlı açıqlama verən Putin Türkiyə şirkətlərinin Rusiya bazarındakı paylarını itirə biləcəklərini qeyd edərək, SU-24-ün vurulmasının Türkiyə-Rusiya ortaqlayihələrinin sonlanmasına yol açma biləcəyini ifadə etmişdi [9].

Rusiyada fəaliyyət göstərən şirkətlər içərisində daha geniş yayılanları sırasında Anadolu Efes, Anadolu Glass, Trakya Glass, Bottle Glass, Arçelik, Türk Hava Yolları, Tüpraş və Enka İnşaat və s. adlarını çəkmək olar. Anadolu Efes şirkətinin Rusiyada iri həcmli pivə biznesi var. Pivənin ümumi həcmi 50%-ni Rusiyadan əldə edir. Eyni zamanda şirkət ümumi spirtli içki istehsalının 50.3%-nə sahiblik edir. Anadolu Glass şirkəti ümumi satışlardan əldə etdiyi gəlirin 35%-i Rusiyadan alır.

Rusiyanın düz şüşə istehsalı sahəsində ən böyük rolə malik olan firması isə Trakya Camdır. Belə ki, Rusiya bazarında 70% paya sahibdir. Rusiyada böyük istehsal müəsisəsi quran Arçelik firmasının ümumi satışlarından əldə edilən gəlirin 3%-i Rusiya və Ukraynanın payına düşür. (2015-ci il üzrə statistik göstəricilərdir).

Rusiyada fəaliyyət göstərən Türk biznesinin böyük əhəmiyyətli sahələrindən biri də tikinti sektorudur. Eyni zamanda tikinti şirkətində çalışan işçi qüvvəsinin də böyük hissəsini türk vətəndaşları təşkil edir. lakin, 2015-ci ildə baş verən böhran bu sahədə ciddi geriləməyə səbəb olmuşdu. Lakin münasibətlərin bərpa edilməsi ilə ticarət və iqtisadi sahədəki gerilik aradan qaldırılmışdı. Rusiyada bir sıra dövlət əhəmiyyətli binaların tikintisində Türk tikinti şirkətlərinin rolə olmuşdu. Bunlardan Kazan Pensiya Fondunun binası, Volkswagen Avtomobil Zavodu, Soçi Olimpiya Komitəsi Hotel, İzhevsk şəhərində logistik mərkəz, "Smolensky" çoxməqsəli kompleksinin tikintisi, Oçapovski xəstəxanası, Krasnodar İdman Kompleksi, Böyük Britaniya səfirliyinin yaşayış binasının

restavrasiya tikintisi, Paytaxt şəhər qalalarının tikintisi, Ruski Standart Vodka istehsal müəssisələrinin tikintisi və s. misal çəkmək olar.

Rusiyada Türk şirkətləri fəaliyyət göstərdiyi kimi, eyni qaydada Türkiyədə də Rusiyalı biznesmenlərin ortaq şirkətləri qurulmuş, bununla qarşılıqlı münasibətlər fonunda ciddi inkişaf nəzərə çarpmışdı.

2022-ci ildə təsis edilmiş xarici kapitalla malik şirkətlərin 61,9 faiz olduğu halda onun 49.8%-ni Rus şirkətləri təşkil edir. Onların sayı əvvəlki illərlə müqayisədə artaraq 177-dən 1363-ə yüksəlmişdi. Bu rəqəm 2018-ci ildə 29, 2019-cu ildə 27, 2020-ci ildə 33, 2021-ci ildə 39 olmuşdu. 2022-ci ildə Rus şirkətlərinin Türkiyəyə daha çox yaxınlaşmasının əsas səbəbi isə Rusiyanın Ukrayna ilə müharibəyə başlamasından sonra Avropa və dünya dövlətlərinin bəzilərinin embarqo tətbiq etməsidir. Daşınmaz əmlak sektorunda fəaliyyət göstərən "Inhouse Global" şirkətinin Direktorlar Şurasının sədri Fatih Ergüven Rusiyaya qarşı embarqo prosesi zamanı Rusiya şirkətlərinin Türkiyəyə yönəldiklərini bildirərək: "Onlar əsasən anbar və zavod sahələrini alırlar. İstanbul, İzmit, Bursa, Çorlu və Tekirdağ fabriki üçün gündəmə gəlir. Eyni zamanda, turizm sahəsinə sərmayə qoyanlar da var" demişdi [12].

Rusiyadan Türkiyəyə edilən sərmayələr içərisində Neft kimya, dəmir və polad, logistika, maşınqayırma, sub-sənaye və tekstil sektorları üstünlük təşkil edir. Bu dövrdə Avropa ilə ticarət iqtisadi əlaqənin qurulmasında Türkiyə vasitəçilik missiyası yerinə yetirməklə daxili iqtisadiyyatında da inkişafa nail ola bilir. Rusiyanın yüngül sənaye sahələrindəki zəifliyi Türkiyəli iş adamlarının və firmalarının buraya daha çox diqqət ayırmalarına səbəb olmuşdu. LC Waikiki, Colin's, DeFacto və Koton firmaları Rusiyanın daxili bazarında söz sahibi olaraq çoxlu sayda mağalarını açmağa nail olmuşdular. Belə ki, 1,5 il ərzində bu firmaların 28 satış obyektləri açmışdılar.

Turizm sektoru Türkiyə-Rusiya münasibətlərində iqtisadi və mədəni komponentlərdən biri kimi xüsusi yerə sahibdir. 2011-ci ildə iki ölkə arasında viza rejiminin sadələşdirilməsi və qarşılıqlı hava nəqliyyatının artırılması turizm sahəsində də irəliləyişə səbəb oldu. 2015-ci ildə baş verən təyyarə qəzası qarşılıqlı ikitərəfli münasibətlərin pozulması ilə nəticələnsə də 2016-cı ildən normallaşma prosesi siyasi, iqtisadi və mədəni əlaqələrin də bərpa edilməsinə gətirib çıxartdı. Turizm sektoru iqtisadi olmaqla yanaşı hər iki dövlətin ictimaiyyətində mədəni sahədə də körpü qurulmasında mühüm əhəmiyyət kəsb edir. Türkiyəyə gələn turistlər içərisində əsas çoxluq rusa məxsusdur. Xüsusilə də 2019-cu Türkiyə 7 milyon rus turisti qarşılamışdı. Bu da həmin ildə ümumi turist sayınının 16%-ni təşkil edirdi. Lakin COVID-19 pandemiyası səbəbindən nəqliyyat yollarının bağlanması turist axınının azalmasına və iqtisadi baxımdan zəyifləməyə səbəb oldu. 2021-ci ildən "Təhlükəsiz Turizm Sertifikatı" proqramı ilə əlaqələr bərpa edildi. 2020-ci illə 2025-ci ilin statistikasına əsasən deyə bilərik ki, Türkiyəyə gələn turistlər içərisində Rusiya birinci Almaniya isə ikinci sırada gəlir. İngiltərədən gələn turistlər 2021-ci ildə 4minə çatsa da həmin ildə Bolqarıstandan gələn turist sayı 1,5 milyon nəfərə çatmışdı. Bu cür nəticə Türkiyənin Balkanlarda apardığı siyasətinin nəticəsi idi [7].

2015-2023-cü illər üzrə Türkiyəyə gələn rus turistlər və Rusiyaya gedən türk turistlər

İl	Türkiyəyə gedən Rus turistlər (min nəfər)	Rusiyaya gedən Türk turistlər (min nəfər)
2015	4,479	1,200
2016	4,539	1,300
2017	4,649	1,400
2018	6,488	1,500
2019	6,621	1,600
2020	900 (COVID-19 səbəbi ilə azalma)	300 (COVID-19 səbəbi ilə azalma)
2021	2,100	700
2022	3,900	1,100
2023	4.500	1,400

Eyni qaydada Rusiyada da ən çox səyahət edilən ölkə kimi Türkiyə əsas üstünlük təşkil etmişdi. 2022-ci ildə Rusiyadan Antalyaya gələn turist sayı 3 milyonu keçmişdi. Həmin ilin üçüncü və dördüncü rübündə turist axını Covid-19 pandemiyasından əvvəlki miqyasına geri qayıdıb. 2019-cu ildən sonra bu sektorda görülən ən yüksək göstərici 2023-cü ildə nəzərə çarpdı. Həmin ilin statistikasına görə rus turistlərin ən çox ziyarət etdikləri ölkələr içərisində Türkiyə ilə Tayland ön sırada yer aldı. 2023-cü ildə rusiyalıların xaricə səfərləri 20%-dən çox artmış, bu səfərlərin isə 23%-i Türkiyəyə olmuşdu. 2023-cü ilin dekabr ayında 60 mindən çox rusiyalı turist Antalyaya səfər etmişdi. Bu nəticə isə 2022-ci ilin dekabr nəticələri ilə müqayisədə 28,4% azalmışdı 2022-ci ildə Rusiyadan Özbəkistana gələn turist sayı isə 2021-ci illə müqayisədə 3 dəfə artaraq 568 min nəfərə çatıb. 2023-cü ildə isə bu say artaraq 714,2 min nəfərə qalxmışdı. 2017 və 2018-ci illərlə müqayisədə göstəricələrdə dəfələrlə artım müşahidə edilirdi. Turist axınının bu qədər artması qarşılıqlı ikitərəfli münasibətlərin yüksələn xətlə davam etdiyini göstərir. Bu da Rusiyanın bölgədə yeritdiyi iqtisadi, mədəni maraqlarının göstəricisi hesab olunur [6].

Beləliklə, Türkiyə ilə Rusiya arasında iqtisadi əməkdaşlıq sahələri siyasi gərginliklərdən təsirlənsə də, milli maraqları naminə ikitərəfli əlaqələrin daha uyğun həll yolu olaraq görməklə rəqabətlə əməkdaşlıq xətlərini paralel formada davam etdirməyə çalışırlar.

Beləliklə, Türkiyə ilə Rusiya arasında mövcud olan diplomatik siyasi münasibətlər tarixin müxtəlif dövrlərində yüksələn və enən xətlə davam edərək, mürəkkəb dinamikanın yaranmasına səbəb oldu. Xüsusilə də, son 10 ildə baş vermiş proseslər, qarşılıqlı əməkdaşlıq və rəqabət modellərinin paralel formada irəliləməsinə zəmin yaratmışdı. Regionda nüfuza sahib olan iki böyük dövlət arasındakı münasibətlərin Suriya münaqişəsi, Liviya böhranı, Qarabağ problemi və Ukrayna müharibəsi dövründə sınağa çəkildiyinin şahidi olduq. Belə qarışıq dövrdə həm Türkiyə həm də Rusiya öz dövlətlərinin milli maraqlarını əsas gətirərək rəqabətli əməkdaşlıq modeli çərçivəsində qarşılıqlı ikitərəfli münasibətlərin qorunub saxlanılmasına nail oldular.

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LUCKY ACCIDENTS AND HIDDEN REGULARITIES: HOW HUMAN CIVILIZATION WAS FORMED

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Abstract

This article examines the emergence and development of human civilization as a result of the complex interplay of chance and historical patterns. The authors trace the path from the emergence of life on planet Earth to the present day, demonstrating how numerous processes and characteristics of nature and humans influenced the emergence of civilization. Attention is paid to the role of rare coincidences - from the oxygen catastrophe to solar activity. The article raises the question: is the emergence and development of civilization a product of lucky accidents or a predetermined pattern.

Keywords: civilization, chance, evolution, natural conditions, climate, resources, social organization, progress, prerequisites.

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УДАЧНЫЕ СЛУЧАЙНОСТИ И СКРЫТЫЕ ЗАКОНОМЕРНОСТИ: КАК СФОРМИРОВАЛАСЬ ЧЕЛОВЕЧЕСКАЯ ЦИВИЛИЗАЦИЯ

Аннотация

В статье рассматривается появление и развитие человеческой цивилизации как результат сложного взаимодействия случайностей и исторических закономерностей. Авторы прослеживают путь от появления жизни на планете Земля до сегодняшнего дня, показывая, как многочисленные процессы и особенности природы и человека повлияли на появление цивилизации. Уделяется внимание роли редких совпадений - от кислородной катастрофы до солнечной активности. В статье поднимается вопрос: появление и развитие цивилизации является продуктом удачных случайностей или predetermined закономерностью.

Ключевые слова: цивилизация, случайность, эволюция, природные условия, климат, ресурсы, социальная организация, прогресс, предпосылки.

Несомненно, происхождение жизни - это один из ключевых вопросов науки, на которые нет однозначного ответа. Но это связано не с отсутствием каких-либо свидетельств и фактов, а с тем, что концепций много и главная сложность заключается в понимании, какая именно является верной. В материале группы исследователей под руководством Евгения Кунина из Национального института здоровья США и опубликованные в *Proceedings of the National Academy of Science*, которые можно свести к тому, что первая жизнь появилась в водах пресных озер [1, с. 821], подогревавшихся и насыщавшихся микроэлементами из доисторических геотермальных источников.

И если такие взгляды верны, то в далеком прошлом нашей планеты был относительно короткий период, когда условия способствовали этому самому процессу зарождения живого. Можно сказать, что на Земле сложились крайне удачные обстоятельства. Хотя современная наука утверждает, что те же органические соединения вообще могут синтезироваться в условиях межзвездного пространства [2, с. 427], и всевозможные цепочки аминокислот пептиды или входящие в ДНК нитрилы могут образовываться просто в открытом космосе, однако в отличие от органических соединений как таковых процесс возникновения жизни явление достаточно сложное, как и ее развитие.

Ведь из более чем четырех миллиардов лет существования большую часть времени она была одноклеточной. И вполне возможно, что в целом многоклеточность и покорение суши и тем более разумной жизни могло бы и не быть. Как тут не вспомнить пресловутый великий фильтр Робина Хэнсона, согласно идеям которого тот факт, что мы дошли до стадии технологической цивилизации - это большое везение и очень вероятно, что это везение скоро закончится.

Также, пожалуй, стоит вспомнить формулу Дрейка, предназначенную для определения числа внеземных цивилизаций в галактике. Проблема в том, что пока мы не можем ей полноценно пользоваться, не имея данных даже о частоте возникновения жизни. Хотя обнаружение даже самых примитивных форм на Марсе, Венере или еще где сдвинули бы чашу весов к идее, что жизни во вселенной необычайно много.

Впрочем, размышления об уникальности этой самой жизни и пути, которые она проделала до появления цивилизации – это лишь верхушка айсберга. Любая картина мира тесно связана с такими понятиями как время и пространство. И в голове у каждого или практически каждого есть более-менее понятная система координат с точкой начала отсчета некоторой периодизации и текущим моментом.

Часть населения, которая старается опираться на рациональные принципы, представляет вселенную как череду событий от большого взрыва и до современности. В наши дни, создавая самый разнообразный контент, блогеры начали на взаимовыгодных условиях приглашать серьезных ученых на подкасты. И эти самые ученые стали некоторым связующим звеном между миром науки и населением.

Благодаря им можно прикоснуться к, казалось бы, фантастической информации о том, что мультивселенная - это далеко не выдумка сценаристов очередного фильма, а существующая обоснованная интерпретация нашей реальности, подразумевающая огромное количество других вселенных с разными свойствами вакуума. Кроме того, этот самый вакуум не пустота, а нечто способное производить частицы. И собственно-то, пока одни размышляют, как много обстоятельств совпало, чтобы на Земле возникла жизнь, вполне может оказаться, что нам повезло в разы больше.

Ведь во многих других вселенных физические законы вообще могут не позволять появляться даже звездам, планетам и другим небесным телам. И тем более такой сложной организации материи, как жизнь. Впрочем, подобные идеи интерпретации скорее указывают на то, что человек, несомненно, может продвинуться в понимании окружающего мира.

Однако, когда наука обращает свое внимание на квантовый микромир или космический макромир, формулы и расчеты предоставляют такую информацию, которую наш мозг, развивавшийся как средство решения практических задач, порой затрудняется вообразить. Одно можно сказать точно, очень много обстоятельств сложились строго определенным образом, чтобы появилась не только жизнь, но и то, что мы называем цивилизацией.

Так, например, около двух с половиной миллиардов лет назад произошла кислородная катастрофа [3, с. 307]. Фотосинтезирующие организмы загрязнили атмосферу ядовитыми отходами своей жизнедеятельности - кислородом, вследствие чего большая часть жизни, на тот момент анаэробной погибла. Отдельные формы приспособились к новым условиям.

Если бы кислородной катастрофы не было, а жизнь каким-то образом развилась до сложных и разумных форм, это бы вызвало ряд серьезных проблем. Без кислородной атмосферы невозможен открытый огонь, поэтому погреться у костра или обжечь керамическую посуду не получилось бы. А также не получилось бы выплавить металл, поскольку, как нетрудно понять, для работы примитивной сыродутной печи или огромной домной нужен процесс горения, для которого, в свою очередь, необходим кислород.

Каменный век, который начался более двух миллионов лет назад. К изготовлению первых орудий приступили существа, малопохожие на человека разумного. А ко времени формирования нашего вида несколько сотен тысяч лет назад, обработка камня достигла достаточно высокого уровня.

Но далеко не каждый камень позволяет получить режущую кромку. И хоть пород, пригодных для этого достаточно много, однако проблема в том, что практически все они встречаются редко на ограниченных территориях, кроме, пожалуй, кремня, из которого изготовлена львиная доля каменного инвентаря. Но чтобы эта порода возникла, должен был совпасть целый ряд факторов.

Во-первых, на его появление сказалось поведение земной коры, которая на разных участках время от времени то поднималась, то опускалась, вследствие чего на большей части суши в тот или иной период было море. Во-вторых, повлиял тот факт, что в этих самых морях обитали существа, обладающие раковинами и скелетами определенного химического состава, которые, погибая, формировали многометровые слои известняков. В-третьих, сложные химические процессы, поскольку кремень это биогенная порода, то есть в пластах, некогда бывшими в прошлом костями и раковинами живых существ, шли процессы, итог которых появление кремневых конкреций, а они уже стали на несколько миллионов лет главным ресурсом.

В наши же дни известняки, остатки древних животных служат сырьем для производства цемента и, соответственно, бетона, главного строительного материала современности. Но не будь кремня, человек бы все равно изготавливал орудия из камня, но география территорий, где это можно было бы сделать, стала бы очень узкой. Например, тот же Обсидиан встречается только в местах с вулканической активностью.

Расселяться же, например, в самом большом биоме плейстацена - тундра-степи, да и не только, без возможности изготавливать каменные орудия труда было бы как минимум сложно, потому как по своему значению кремень для палеолита был чем-то похож на железо

в более поздние времена. Не будь его в природе, далеко не факт, что, например, каменный век бы закончился именно в нашем межледниковье - голоцене. Да и вообще закончился бы, поскольку отсутствие кремня вполне вероятно негативно бы сказалось на географии расселения и демографических показателях нашего вида.

Также стоит отметить, что человечеству повезло со свойствами многих минералов и пород. Так, например, тот факт, что глине с водой можно придать определенную форму, а высыхая или будучи обожженная она становится твердой, позволил создавать разнообразную посуду для хранения, а также строить жилища.

Ну а в более поздние времена не последнюю роль в развитии металлургии сыграли некоторые обитающие в болотах виды бактерий, продукты жизнедеятельности которых с содержанием железа оседали на корневище и прочей поверхности и формировали сырье для производства кричного железа [4, с. 394] в регионах, где не было выхода руд. Ну а когда человечество подошло к индустриальному обществу и нуждалось в новых источниках энергии, оказалось, что в далеком прошлом Земли возникали условия, не позволяющие органике полностью распадаться. И огромные залежи каменного угля и нефти, содержащие колоссальные запасы энергии, лежали буквально под ногами.

При этом уголь, который на первых порах было легче использовать, зачастую просто пластами выходил на поверхность. В плане обеспечения от цивилизации ресурсами планета напоминает яйцо, где помимо зародыша имеется белок, содержащий все необходимое для его развития.

Последние несколько миллионов лет на планете господствует суровый ледниковый период, когда холодные гляциалы сменяют более теплые интергляциалы - межледниковья.

У смены и продолжительности этих периодов нет четких границ. Теплое межледниковье - голоцен, в котором мы живем, могло и не наступить 12 тысяч лет назад, а наступив - быстро закончится, что, вероятно, поставило бы крест на развитии производящего хозяйства в целом или как минимум его распространения на большей части планеты. Это самое производящее хозяйство является фундаментом цивилизации.

И если вы начнете спрашивать столь популярные в наши дни нейросети о причинах его появления, то они выдадут ряд тезисов. Однако даже в нашем с вами XXI веке точно обозначить причины неолитической революции сложно, потому как не сказать, чтобы переход к выращиванию растений сделал жизнь древних людей гораздо более сытой. Показатели здоровья в это время снижаются, как и средний рост [5, с. 13722].

Рацион становится более однообразным, зато появляется алкоголь, в частности, ячменное пиво. Есть воззрения, что причиной возникновения земледелия вообще могло быть производство этого самого алкоголя. А такие исследователи, как Эдвард Слингерленд, считают, что алкоголь и вовсе двигатель развития цивилизации.

Так или иначе, нужно понимать, что древнейшая выращиваемая человеком культура, ячмень, как и позже появившаяся пшеница были далеки от современных. Никаких толстых и мощных колосьев. И вследствие этого мест, где можно было более-менее эффективно заниматься земледелием, существовало крайне мало.

Говорим мы о Междуречье, Египте, территории Индии, Китая или таких отдаленных центрах земледелия, как южноамериканские Анды. Везде оно в той или иной степени было связано с реками и сезонами дождей. Когда разливаясь, водные артерии выносили на берега ил, в котором хорошо росли растения.

И только когда посевной материал прошел тысячелетний путь селекции, появились новые орудия труда и методы возделывания земли, производящее хозяйство начало свое продвижение на север. Но самому факту возникновения земледелия мы обязаны зонам с теплым климатом, реками и сезоном дождей.

Сам факт появления цивилизации связан с рядом моментов.

С одной стороны, с иерархической пирамидой, которую выстраивают многие приматы, да и не только. И, по сути, эгоистичное стремление подняться над остальными и жить с подконтрольных земель, опираясь на силу и авторитет, породило государство.

В основе первых, да и не только первых государств стояла военная сила и эксплуатация меньшинством большинства. Что, с одной стороны, заставляло среднего человека работать так, как он никогда до этого не работал. С другой породило цивилизацию, главными критериями которой являются города и письменность.

Собственно, первой удачей на этом пути стал один неприметный момент. На протяжении сотен тысяч лет люди жили небольшими группами, очень редко имевшими численность более трех десятков человек. И сам факт, что в ходе появления первых городов сотни и тысячи людей смогли жить совместно - большая удача.

Хотя для этого и пришлось придумывать много костылей, как, например, наказывающих за неправильное поведение богов. В наши дни, на примере современных мегаполисов, мы знаем, что высокая плотность населения негативно влияет на психику и провоцирует стресс [6, с. 135]. Однако, будь эта реакция более выражена, и никаких первых городов могло бы и не возникнуть.

Люди бы просто сходили с ума или разбежались из крупных поселений, в которых до этого им никогда не приходилось жить. Амбиции же человека часто не имеют границ, и это, как ни странно, тоже в определенный момент было положительным явлением.

Это может нравиться или нет, но цивилизация - продукт неравенства. Сам процесс ее возникновения, судя по всему, являлся некоторой закономерностью в тех условиях, в которых люди жили в нашу эпоху голоцена.

Поскольку цивилизации возникали независимо друг от друга на разных континентах, при этом тот или иной правитель не ограничивался властью над одним или несколькими селами, площадь его земель росла. Это порождало потребность в появлении налоговой системы, письменности и арифметики. И в определенном смысле можно сказать, что жадность и амбиции правителей запустили процесс усложнения государства и открыли в нем вакансии для умных людей, способных вести подсчеты и прочие записи.

И они вместе с развитием ремесла в городах начали потихоньку двигать науку, которая, впрочем, всегда находилась и находится на задворках истории. Так, например, в наши дни развитые страны тратят на нее обычно чуть более 1% от ВВП, в топе по расходам государства, вкладывающие в науку от 3 до 5%, как, например, Япония, Южная Корея и Израиль. При этом такой современный, самый дорогой научный проект как Большой Адронный Коллайдер стоит в 2-3 раза дешевле одного авианосца.

Однако тот факт, что в наше время строят эти самые Адронные Коллайдеры, авианосцы и много чего еще, тоже результат стечения множества обстоятельств. Читая то или иное фэнтези, вы могли не раз наткнуться на миры, живущие с аграрным типом экономики и при феодализме на протяжении десятков тысяч лет. Эдакое застывшее в веках традиционное общество.

И на самом деле между успешным человеком и историей нашей цивилизации есть один общий момент. Достигнув определенного результата, успеха, человек начинает думать, что все это было предрешено. А его высокое положение - неизбежный итог врожденных и приобретенных способностей и трудов.

Точно так же с высоты современной цивилизации легко рассуждать о стадиях развития общества и неизбежности прогресса.

Не сложись в средневековой Европе категория свободных городов, живущих ремеслом и торговлей, все могло бы быть совсем иначе.

Появление этих самых свободных городов стало возможно благодаря противоречиям между королями и феодалами помельче, собственниками земель, пользуясь чем, многие населенные пункты достигали независимости. А в этих городах сформировалась состоятельная прослойка, способная впоследствии бросить вызов феодальной знати. И это происходило на фоне изменения севооборота, особенно появления четырехполья, дававшему возможность городам расти, поскольку для производства определенного объема еды теперь нужно было гораздо меньше рабочих рук.

Разрушить традиционное аграрное общество и построить индустриальное могло бы и не получиться. Не было бы и промышленной революции, перехода от ручного труда к труду машин. Ведь по итогу все инновации нового времени распространялись из Европы.

И это связано не с тем, что там жили какие-то особые сверхумные люди. Просто исторический ряд факторов сложился таким образом, что именно там было кому развивать промышленность, и это было выгодно. Остальные части света, вернее государства, не ставшие колониями, видя успехи, тем или иным способом копировали достижения.

Собственно, возможность копировать у соседей - это важный элемент прогресса. Так, например, американские цивилизации существовали более 3000 лет, но за это время так и не освоили черные металлы, хотя залежи руды там не были редкостью. А те же инки вообще даже в период, по сути, европейского средневековья имели очень архаичную экономику, в которой не было денег, использовался прямой обмен.

И вполне возможно, что они бы могли еще многие тысячи лет существовать на том же технологическом уровне. Ситуация с американскими территориями говорит, что для развития цивилизации важным является наличие больших просторов, где разные государства могут не только конкурировать, вести военные действия, но и осуществлять торговлю, а также взаимно копировать друг у друга технологии. И если бы конфигурация материков была иной, и на планете существовали отдельные клочки суши, разделенные большими водными пространствами, это могло бы изрядно замедлить прогресс.

Хоть по мнению профессора Карла Хампе - история не терпит слагательного наклонения, но если представить, что до трансформации Европы и разрушения традиционного аграрного общества в новое время не произошло, случилось бы все это в других частях света, и если да, то когда? Через век-два, а возможно и тысячи лет? И как в том или ином фэнтези, люди могли бы еще долго, а возможно и до исчезновения цивилизации, махать мотыгами на полях. Ведь это мы живем в век бурных инноваций. А средневековый крестьянин, который попал бы в прошлое на пять веков или более, не сказать, что бы очутился в мире других технологий.

Люди рождались и умирали, не замечая каких-то серьезных изменений в социальном устройстве, предметах быта, инструментах, зачастую цепляясь за традиции и не желая воспринимать что-то, способное повысить эффективность труда. Например, ту же косу Петр Первый продвигал на законодательном уровне, рассылая даже по селам людям, обучавших работе с этим инструментом [7, с. 513]. И хоть коса как минимум в два раза эффективнее серпа, народ активно сопротивлялся новшеству.

И о преимуществах косы писали даже во времена СССР. Однако серп являлся традиционным орудием, начиная с неолита, и люди очень держались за старый инструмент. Традиции выступали некоторой системой защиты, и на протяжении истории мало было придумать что-то полезное.

Гораздо сложнее было его внедрить. Собственно, в каменном веке тот или иной тип орудий труда индустрия могли существовать тысячи и десятки тысяч лет. И причиной тому,

судя по всему, является верность традициям, а не отсутствие творческой жилки, изобретательства и инноваций.

Некоторым лозунгом людей прошлого была фраза «Работает, не трогай». То время, когда человек стал воспринимать прогресс как источник чего-то полезного, наступило буквально вчера. И за этим стоит не полезность изобретений, а появление институтов, которым стало выгодно производить и продавать инновационный товар.

При этом появление чего-то нового большая часть населения всегда воспринимала в штыки. Сам переход от традиционного аграрного общества к индустриальному - это в определенном смысле чудо. Но пройдя индустриализацию, цивилизации тоже несказанно повезло.

По результатам исследований, опубликованного в журнале Science, супервспышки на таких звездах, как наше Солнце, случаются в среднем раз в сто лет. Исследование проводилось на основе данных о 56 450 солнцеподобных звездах, полученных космическим телескопом НАСА Кеплер в период с 2009 по 2013 год. И, как оказалось, экстремальные вспышки являются естественной частью солнечной активности [8, с. 479].

Последнее такое событие, вероятно, произошло в 1859 году. Речь о событии Керрингтона, когда вспышка на Солнце привела к мощной геомагнитной буре [9, с. 14]. По телеграфным проводам прошли настолько мощные токи, что операторы получали ожоги, а в некоторых телеграфных станциях возникали пожары.

Однако, по очередной счастливой случайности, весь период становления и развития электроники и покорения околоземного пространства припал на период, когда Солнце вело себя очень спокойно. Хотя, если бы сейчас или десяток-другой лет назад Землю накрыла супервспышка, это было бы чревато выходом из строя большого количества электроники, в особенности спутников на орбите. И, вероятно, мы бы жили уже как минимум в несколько другом мире.

На самом деле, очень сложно сказать, чем является развитие нашей цивилизации - чередой удачных случайностей или закономерностью. И ситуация с появлением разумной жизни на самом деле выглядит намного более простой, поскольку там, где этой самой разумной жизни нет, некому и задаваться вопросом о ее возникновении. Впрочем, многие ответы человечество, вероятно, получит в ближайший век, если, конечно, продолжит свое существование.

Поскольку мы живем в столь стремительно меняющемся мире, когда студент, поступающий на первый курс университета, не знает, какие вакансии будут актуальны через 5-6 лет, к моменту получения им диплома. И примерно за эти самые 5-6 лет, по некоторым расчетам, сумма научных знаний в мире удваивается [10, с. 32]. То есть, ученые узнают примерно столько же, сколько и за всю предыдущую историю.

Само же развитие цивилизации напоминает бег в слепую, при котором бегун движется все быстрее и быстрее. И пока у него это получается, но до конца непонятно, движется он по специальной трассе к некоторой цели или же дикой местности, и в любой момент может упасть с обрыва или влететь в дерево. Так или иначе, но по итогу, время гораздо лучше дает ответы на вопросы, нежели футурологи и аналитики.

И возможно, за ближайшие годы и десятилетия жизни нашей произойдет столько событий, сколько не происходило за жизни многих поколений. Так уж сложилось, что человечеству достались билеты на весьма динамичную часть фильма под названием «История».

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Формирование гендерного равноправия в Германии: идеи, реформы и политическая борьба женщин Империи (1871-1918)

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Аннотация. В статье рассматривается вклад четырёх выдающихся женщин Германской империи — Хелен Ланге, Клары Цеткин, Лили Браун и Аниты Аугспург — в развитие женского движения в период с 1871 по 1918 год. Анализируются их разные подходы к расширению прав женщин: реформаторское направление, ориентированное на образование и юридические изменения, и социалистическое, акцентирующее внимание на политической борьбе и социальной справедливости. Статья показывает, как сочетание этих стратегий способствовало превращению женского вопроса из маргинальной темы в ключевой элемент общественных реформ, завершившихся введением всеобщего избирательного права в Веймарской республике.

Annotation. This article examines the contributions of four prominent women of the German Empire — Helene Lange, Clara Zetkin, Lily Braun, and Anita Augspurg — to the women's movement between 1871 and 1918. It analyzes their differing approaches to expanding women's rights: the reformist path focused on education and legal reforms, and the socialist path emphasizing political struggle and social justice. The article demonstrates how the combination of these strategies helped transform the women's issue from a marginal topic into a central element of social reforms, culminating in the introduction of universal suffrage in the Weimar Republic.

Ключевые слова: Женское движение, Германская империя, Хелен Ланге, Клара Цеткин, Лили Браун, Анита Аугспург, права женщин, реформы, социализм, избирательное право

Key words: Women's movement, German Empire, Helene Lange, Clara Zetkin, Lily Braun, Anita Augspurg, women's rights, reforms, socialism, suffrage

Актуальность темы. Изучение роли выдающихся женщин в истории Германской империи имеет важное значение для понимания процессов социально-политических преобразований конца XIX — начала XX века. Женское движение в этот период не только отражало борьбу за равноправие, но и стало важным фактором модернизации общества в целом. Анализ деятельности Хелен Ланге, Клары Цеткин, Лили Браун и Аниты Аугспург позволяет выявить разные стратегии и подходы к решению проблем дискриминации женщин, что актуально для современных исследований гендерной истории и политики равноправия.

Историография вопроса. Вопрос женского движения в Германии широко освещён в трудах как зарубежных, так и отечественных историков. Классические исследования Ричарда Эванса [4], Уте Герхард [8] и Анны Тейлор Аллен [6] рассматривают развитие феминизма в контексте социальных и политических изменений. Работы, посвящённые отдельным фигурам — Хелен Ланге [1], Кларе Цеткин [2], Лили Браун [3] и Аните Аугспург [7] — дают возможность глубже понять их личный вклад и идеологические различия. В последние годы растёт интерес к междисциплинарным подходам, сочетающим историю, гендерные исследования и социологию, что способствует более комплексному осмыслению женского движения в немецкой истории.

Введение

Период существования Германской империи (1871–1918) стал временем масштабных социальных преобразований, но именно женщины оказались в наиболее противоречивом положении. С одной стороны, индустриализация и рост городов создавали новые профессиональные и образовательные возможности. С другой — правовая система сохраняла традиции, ограничивавшие доступ женщин к политическим и академическим сферам. В этих условиях возникает мощное женское движение, которое объединяет как буржуазных реформаторок, так и социалисток.

Социально-политический контекст эпохи

В конце XIX века Германия переживала быстрый экономический подъём. Индустриализация изменила структуру занятости, втянув женщин в промышленное производство, однако условия их труда и правовой статус оставались неудовлетворительными [6]. Женщины не могли получать полноценное высшее образование, занимать государственные должности и участвовать в выборах.

Женское движение постепенно разделилось на два направления. Первое — буржуазно-реформистское — стремилось к улучшению образования и правового статуса женщин через постепенные реформы. Второе — социалистическое — опиралось на рабочий класс и выступало за коренные изменения политической системы [4]. Несмотря на идеологические различия, обе группы стремились к расширению возможностей женщин в обществе.

Основные направления женской активности

1. Реформа образования: роль Хелен Ланге

Хелен Ланге стала ключевой фигурой в борьбе за модернизацию женского образования. В своей программной работе *Die höhere Mädchenschule und ihre Bestimmung* [1] она

предложила создать новые стандарты преподавания для девочек, утверждая, что женщины должны иметь доступ к тем же знаниям, что и мужчины.

Под её руководством были разработаны улучшенные учебные программы, расширены курсы гуманитарных дисциплин, а позднее — открыт путь женщин к университетским экзаменам. Благодаря настойчивости Ланге к началу XX века женщины начали получать право на университетское образование в Пруссии. Её деятельность стала фундаментом для появления женских гимназий и профессиональных школ.

2. Политическая борьба и социалистическое движение: Клара Цеткин

Клара Цеткин — символ социалистического женского движения Германии. Её тексты и выступления отражали стремление женщин-работниц добиться политических прав, улучшения условий труда и участия в общественных организациях.

В своих работах она анализировала положение женщин-пролетарок и подчёркивала, что без изменения социально-экономической системы невозможно реальное равноправие [2]. Именно Цеткин выступила инициатором учреждения Международного женского дня, что сделало женский вопрос частью глобального политического дискурса.

Она активно участвовала в создании женских секций при социал-демократических организациях и считала, что политическое участие должно быть доступно всем, а не только образованным и обеспеченным женщинам.

3. Социальные реформы и семейная политика: вклад Лили Браун

Лили Браун сочетала теоретический подход с активной политической деятельностью. В своих мемуарах *Memoiren einer Sozialistin* [3] она описывала не только личный опыт, но и социальные проблемы, с которыми сталкивались женщины в эпоху индустриализации.

Она продвигала идею «модельных хозяйств» — коллективных домов, которые могли бы облегчить труд женщин и обеспечить им профессиональный рост. Браун также выступала за реформу брака, расширение прав матерей и поддержку женщин-работниц.

Её теории являлись мостом между социалистическим и буржуазным движением: она видела необходимость социальных реформ, но не отвергала важность личной свободы и образования.

4. Борьба за политические права и юридические реформы: Анита Аугспург

Анита Аугспург стала первой женщиной-юристом в Германии, что само по себе было революционным прецедентом. В работе *Die politische Bedeutung der Frauenbewegung* [7] она анализировала правовые механизмы угнетения женщин и обосновывала необходимость предоставления им избирательных прав.

Аугспург принадлежала к радикальному крылу феминизма. Она активно участвовала в международных конгрессах, занималась пацифистской деятельностью и требовала не просто реформ, а полного юридического равноправия. Благодаря её усилиям вопрос женского избирательного права стал частью политической повестки Германии уже в 1910-е годы.

Сравнительный анализ вклада четырёх деятельниц

Несмотря на различия в биографиях и идеологических позициях, Ланге, Цеткин, Браун и Аугспург действовали в одном направлении — формировали новое представление о роли женщины в обществе. Каждая из них расширяла пространство женской активности, но делала это по-своему.

Общее между ними проявлялось прежде всего в стремлении к просвещению и публичному влиянию. Все четыре деятельницы активно использовали печатные издания как инструмент формирования общественного мнения: Ланге публиковала педагогические работы, Цеткин и Браун создавали влиятельную социалистическую журналистику, Аугспург распространяла идеи правового равноправия. Кроме того, каждая из них участвовала в создании женских

союзов, что позволило объединить отдельных активисток в устойчивое общественное движение [1; 2; 3; 7].

Однако их подходы отражали разные стратегии борьбы. Ланге и Аугспург придерживались реформаторской линии: они стремились доказать необходимость женского равноправия через образование, профессионализацию и юридические изменения. Основной акцент делался на постепенных реформах — от расширения возможностей в школе и университете до изменения семейного и гражданского законодательства [1; 7].

Цеткин и Браун, напротив, видели корни женского неравенства в социально-экономической системе. Для них ключевым инструментом становилась политическая борьба, рабочие союзы и участие женщин в массовых движениях. Их цель заключалась не только в расширении прав, но и в изменении социального строя, который, по их мнению, и порождал дискриминацию [2; 3; 4].

Совокупность этих разных подходов обеспечила широкую поддержку женского движения. Умеренные реформаторские инициативы сделали тему женского образования и профессиональной занятости респектабельной и приемлемой для либеральных кругов. Радикальные социалистические идеи, в свою очередь, придали движению массовую базу и политическое давление. Именно сочетание мягких и жёстких стратегий позволило к 1918 году вывести вопрос женского равноправия из периферии в центр общественных дебатов [4; 5].

Вклад четырёх деятельниц, хоть и направленный разными путями, создал условия, при которых введение всеобщего женского избирательного права в Веймарской республике выглядело уже не революцией, а логичным итогом десятилетий интеллектуальной, правовой и политической борьбы [6; 8].

Заключение

Деятельность Хелен Ланге, Клары Цеткин, Лили Браун и Аниты Аугспург стала важнейшим фактором трансформации германского общества в период Империи. Их усилия заложили основу для модернизации образования, укрепления социальных прав женщин, развития женского политического движения и формирования новых правовых норм.

Несмотря на различные идеологические позиции, эти четыре женщины сумели изменить общественное восприятие роли женщины и подготовить путь для реформ конца 1910-х годов. Их наследие продолжает оставаться важной частью исторического осмысления женского движения как в Германии, так и в Европе в целом.

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УДК 94(574)

Распад СССР и путь Казахстана к НЕЗАВИСИМОСТИ

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The collapse of the USSR and Kazakhstan's path to independence.

Abstract. *This paper analyzes the collapse of the Soviet Union and the emergence of independent Kazakhstan. The study examines the causes and consequences of the USSR's dissolution, as well as the key stages in the acquisition of Kazakhstan's statehood. Particular attention is paid to the internal and external factors influencing the process of independence, as well as the tasks and challenges Kazakhstan faced in establishing a sovereign state. This paper helps us understand the historical significance of this period and its impact on the contemporary development of the country and the region as a whole.*

Keywords: *Collapse of the USSR, Independence of Kazakhstan, Sovereignty, December Events of 1986, Economic Stagnation, National Self-Awareness, Anti-Nuclear Movement*

Аннотация. *Данная работа посвящена анализу процессов распада Советского Союза и становления независимого Казахстана. В ходе исследования рассматриваются причины и последствия распада СССР, а также ключевые этапы обретения казахстанской государственности. Особое внимание уделяется внутренним и внешним факторам, влияющим на процесс становления независимости, а также задачам и вызовам, с которыми столкнулся Казахстан на пути формирования суверенного государства. Настоящая работа помогает понять историческую значимость данного периода, его влияние на современное развитие страны и региона в целом.*

Ключевые слова: *Распад СССР, Независимость Казахстана, Суверенитет, Декабрьские события 1986, Экономический застой, Национальное самосознание, Антиядерное движение.*

Актуальность темы «Распад СССР и путь Казахстана к независимости» обусловлена её важностью для понимания современного политического и исторического контекста региона. В начале 1990-х годов распад Советского Союза стал одним из крупнейших геополитических событий XX века, оказавшим значительное влияние на международные отношения, внутреннюю политику стран-участников и судьбы миллионов людей.

Для Казахстана данный процесс был особенно важным, поскольку он означал переход от устаревшей советской системы к новой суверенной государственности. В условиях экономического, политического и социального кризиса, страна должна была определить свой путь развития, укрепить национальную идентичность и обеспечить стабильность.

Актуальность исследования также обусловлена современными вызовами, с которыми сталкивается Казахстан: сохранением территориальной целостности, развитием экономики, укреплением демократии и интеграцией в международное сообщество. Понимание исторического опыта становления независимости позволяет лучше осознать сегодняшние процессы и перспективы страны.

Таким образом, изучение распада СССР и пути Казахстана к независимости актуально не только с исторической точки зрения, но и для осмысления современных задач национального развития.

Введение

Распад Советского Союза в 1991 году – событие, кардинально изменившее политическую карту мира и предопределившее дальнейшее развитие множества стран. Эта историческая трансформация не только ознаменовала окончание эпохи биполярного мира и глобального противостояния, но и открыла новые возможности для самоопределения и государственного строительства бывшим союзным республикам. В контексте этих глубинных перемен особое место занимает Казахстан, для которого распад СССР стал отправной точкой на пути к обретению суверенитета и формированию независимого, самостоятельного государства. Эта статья посвящена анализу предпосылок и причин распада Советского Союза, ключевым этапам становления независимости Казахстана, а также тем вызовам и достижениям, которые сопровождали этот сложный и многогранный процесс. Мы рассмотрим, как под влиянием внутренних противоречий и внешних факторов республика прошла путь от протестов и стремления к автономии до провозглашения независимости и начала строительства новой государственности, определив свой собственный, уникальный путь развития в XXI веке.

Распад Советского Союза в 1991 году стал одним из ключевых событий XX века, ознаменовавшим окончание эпохи биполярного мира и перекроившим политическую карту Евразии. Для Казахстана, как и для других союзных республик, этот процесс стал точкой отсчета новой эры – эры независимости и самостоятельного развития. Путь к суверенитету был непростым, полным вызовов и противоречий, но в конечном итоге привел к созданию современного, процветающего государства.

Предпосылки распада СССР: кризис идентичности и экономики

К концу 1980-х годов Советский Союз столкнулся с глубоким системным кризисом. Политика гласности и перестройки, инициированная Михаилом Горбачевым, обнажила накопившиеся проблемы в экономической, социальной и национальной сферах.

- **Экономический застой:** Централизованное планирование, неэффективность производства и дефицит товаров первой необходимости привели к растущему недовольству населения. Экономическая модель, ориентированная на развитие тяжелой промышленности и военно-промышленного комплекса, не обеспечивала достаточное благосостояние граждан.
- **Кризис национальной идентичности:** Политика интернационализма, направленная на стирание национальных различий, не привела к формированию единой советской

идентичности. Напротив, усилились национальные чувства и стремление к сохранению самобытности.

- **Политическая нестабильность:** Ослабление контроля со стороны центральной власти привело к росту политической активности в союзных республиках. Возникли и активизировались национальные движения, выступавшие за расширение автономии и суверенитет.
- **Экологические проблемы:** Бесконтрольное использование природных ресурсов и пренебрежение экологическими нормами привели к серьезным экологическим катастрофам, особенно в Казахстане (Аральское море, Семипалатинский полигон), что усилило недовольство населения деятельностью союзного центра.

Казахстан в период распада СССР: от протестов к декларации суверенитета

Казахстан, как и другие республики, активно включился в процесс перестройки. Однако, в отличие от Прибалтики или Украины, изначально не наблюдалось массового движения за немедленный выход из состава СССР. Во многом это было связано с демографической ситуацией (значительная доля русского населения) и тесными экономическими связями с Россией. Тем не менее, в Казахстане также зрело понимание необходимости расширения своей автономии и защиты национальных интересов.

- **Декабрьские события 1986 года:** Назначение Геннадия Колбина, представителя союзного центра, первым секретарем ЦК Компартии Казахстана вместо Динмухамеда Кунаева, вызвавшее массовые протесты молодежи в Алма-Ате. Эти события стали важным катализатором национального самосознания и показали, что народ готов отстаивать свои права.
- **Движение «Невада-Семипалатинск»:** Мощное антиядерное движение, возглавляемое Олжасом Сулейменовым, привлекло внимание мировой общественности к проблеме ядерных испытаний на территории республики и способствовало закрытию Семипалатинского полигона в 1991 году.
- **Рост национального самосознания:** Активизация национальных общественных организаций и движений, выступавших за сохранение казахского языка, культуры и истории. Развернулась дискуссия о переименовании географических объектов и возвращении исконных названий.
- **Принятие Декларации о государственном суверенитете Казахской ССР:** 25 октября 1990 года Верховный Совет Казахской ССР принял Декларацию о государственном суверенитете, провозгласив верховенство Конституции и законов Казахской ССР на всей территории республики. Этот документ стал первым шагом на пути к независимости.

Августовский путч и провозглашение независимости

Августовский путч 1991 года, организованный консервативными силами в Москве, стал переломным моментом в истории Казахстана. Попытка государственного переворота продемонстрировала неспособность союзного центра контролировать ситуацию и усилила стремление республик к самостоятельности.

- **Нурсултан Назарбаев и его позиция:** В период путча Нурсултан Назарбаев, занимавший пост президента Казахской ССР, занял взвешенную позицию. Он осудил действия путчистов, но при этом призвал к сохранению экономического пространства и политического союза между республиками.
- **Усиление давления со стороны национальных сил:** После провала путча национальные движения и общественные организации в Казахстане усилили давление на руководство республики, требуя немедленного провозглашения независимости.
- **Референдум о независимости:** 1 декабря 1991 года состоялись первые всенародные выборы президента Казахстана, на которых Нурсултан Назарбаев одержал убедительную победу. 10 декабря 1991 года Казахская ССР была переименована в Республику Казахстан.

- **Провозглашение независимости:** 16 декабря 1991 года Верховный Совет Республики Казахстан принял Конституционный закон «О государственной независимости Республики Казахстан», провозгласив независимость страны. Этот день стал национальным праздником – Днем Независимости Республики Казахстан.

Путь к построению независимого Казахстана: вызовы и достижения

После обретения независимости Казахстан столкнулся с многочисленными вызовами. Необходимо было строить новую государственность, формировать рыночную экономику и интегрироваться в мировое сообщество.

- **Политическое строительство:** Принятие Конституции Республики Казахстан в 1995 году, формирование системы органов государственной власти, развитие многопартийной системы и гражданского общества.
- **Экономические реформы:** Переход от плановой к рыночной экономике, приватизация государственной собственности, привлечение иностранных инвестиций, развитие малого и среднего бизнеса.
- **Социальная политика:** Реформирование системы образования и здравоохранения, поддержка социально уязвимых слоев населения, сохранение межэтнического и межконфессионального согласия.
- **Внешняя политика:** Установление дипломатических отношений со странами мира, вступление в международные организации (ООН, ОБСЕ, ШОС и др.), развитие регионального сотрудничества.

За годы независимости Казахстан добился значительных успехов в своем развитии. Была построена современная экономика, значительно улучшено благосостояние населения, укреплен международный авторитет страны. Казахстан стал активным участником международных процессов, выступая за мир и стабильность в регионе.

Заключение

Распад СССР и обретение Казахстаном независимости – это эпохальное событие, предопределившее дальнейший путь развития страны. Путь к суверенитету был сложным и тернистым, но благодаря мудрому руководству, единству народа и настойчивости в достижении намеченных целей Казахстан сумел построить сильное, процветающее и уважаемое в мире государство. Независимость – это не только право на самоопределение, но и огромная ответственность за будущее своей страны. Казахстан успешно справляется с этой ответственностью, продолжая двигаться по пути прогресса и процветания.

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Ясауитану (8-9 сыныптар) (Авторлық бағдарламаны тәжірибеде қолдану және зерттеу нәтижелері)

Исаева Разия Орынбасаровна

Түркістан облысының білім басқармасының Жетісай ауданының білім бөлімінің «Дінмұхамед Қонаев атындағы № 9 ІТ мектеп-лицей» КММ, *Тарих пәні мұғалімі*

Аңдатпа. Бұл мақалада 8-9 сыныптарға арналған «Ясауитану» авторлық бағдарламасының мазмұны, әдістемелік негіздері және оны мектеп тәжірибесінде қолдану барысында алынған нәтижелер талданады. Бағдарлама Қожа Ахмет Ясауи мұралары арқылы оқушылардың рухани-адамгершілік құндылықтарын қалыптастыруды, тарихи-мәдени санасын дамытуды көздейді. Мақалада бағдарламаны жүзеге асыруда қолданылған педагогикалық технологиялар, сабақ үлгілері, жобалық жұмыстар нәтижелері және әдістеменің тиімділігі ғылыми-тәжірибелік тұрғыдан сипатталады. Сонымен бірге авторлық бағдарламаның оқушылардың қызығушылығын арттырудағы, олардың зерттеушілік және сыни ойлау дағдыларын дамытудағы рөлі анық көрсетіледі. Жүргізілген тәжірибелік жұмыстар нәтижелері әдістеменің білім беру үдерісінде тиімді қолдануға болатындығын дәлелдейді.

Түйінді сөздер: Ясауитану, рухани тәрбие, құндылықтар, авторлық бағдарлама, 8-9 сынып, әдістеме, педагогикалық тәжірибе.

Кіріспе

Қазіргі жаһандану дәуірінде жас ұрпақты рухани-адамгершілік құндылықтар негізінде тәрбиелеу – білім беру жүйесінің басты міндеттерінің бірі. Оқушылардың тарихи санасын, ұлттық болмысын, рухани-мәдени дүниетанымын қалыптастыруда түркі өркениетінің көрнекті өкілдері, әсіресе Қожа Ахмет Ясауи мұралары айрықша маңызды. Ясауи ілімі – адам жанын тазартып, ізгілікке үндейтін терең философиялық жүйе. Сондықтан «Ясауитану» пәнін оқыту – ұлттық тәрбиенің мазмұнын байытатын, оқушыларды рухани кемелдікке жетелейтін пәрменді құрал.

Ұсынылып отырған авторлық бағдарлама 8-9 сынып оқушыларына арналған және Ясауи мұрасына кешенді көзқарас ұсынуды мақсат етеді. Бағдарламада Ясауидің өмірбаяны, «Диуани хикметтің» тәрбиелік мәні, түркі сопылық дәстүрлері, Ясауи жолының мәдениетке әсері қамтылған. Бұл бағытта отандық ғалымдар (А.Қыраубайқызы, М.Шафиғи, Қ.Сартқожаұлы), сондай-ақ шетелдік зерттеушілер (F. Köprülü, A. Schimmel, J. Baldick) еңбектерінде маңызды тұжырымдар жасалған. Ясауитанудың білім беру жүйесіндегі рөлі осы ғылыми зерттеулер негізінде нығая түсуде.

Мақаланың негізгі мақсаты – «Ясауитану» авторлық бағдарламасының мазмұнын, әдістемесін және мектепте қолдану тәжірибесін баяндау арқылы оның тиімділігін талдау.

Міндеттері:

- Бағдарламаның теориялық-әдіснамалық негіздерін сипаттау;

- Қолданылған әдістер мен технологияларды жүйелеу;
- Практикалық жұмыстың нәтижелерін талдау;
- Өзге педагогтерге әдістемені қолдануға қатысты ұсыныстар әзірлеу [1].

Әдістеме

Авторлық бағдарлама оқыту процесінде заманауи педагогикалық технологияларды, құндылыққа бағытталған оқытуды, критериалды бағалауды және тұлғалық даму теорияларын интеграциялай отырып жасалған. Әдістеменің негізгі ерекшеліктері төмендегідей:

1. Мазмұндық құрылым

Бағдарлама төрт ірі бөлімнен тұрады:

1. Қожа Ахмет Ясауидің өмірі және тарихи контекст
2. Түркі сопылығы және Ясауи дүниетанымы
3. «Диуани хикмет» – рухани-адамгершілік тәрбие көзі
4. Ясауи жолының мәдениетке ықпалы

Әр бөлімде мәтіндік талдау, тарихи салыстыру, шығармашылық тапсырмалар, дебат, зерттеу жұмыстары қарастырылған.

2. Қолданылған педагогикалық технологиялар

- ❖ **Жобалық оқыту (Project-based learning)** – оқушылар Ясауи хикметтерінің қазіргі өмірмен байланысы туралы зерттеу жобаларын орындады.
- ❖ **Интербелсенді әдістер (INSERT, «Төрт бұрыш», «Әдеби шеңбер»)** – мәтінмен жұмыс тиімді жүргізілді.
- ❖ **STEAM элементтері** – Ясауи кесенесінің архитектуралық ерекшеліктерін геометриялық тұрғыда талдау, хикметтерді аудио-визуалды форматта жаңғырту.
- ❖ **Сыни ойлау технологиясы** – «RAFT», «Ойлан-Жұптас-Бөліс», «Кубизм» әдістері қолданылды.

3. Принциптері

- ❖ Рухани-адамгершілікке бағытталу
- ❖ Мәдени мұраны құрметтеу
- ❖ Тарихилық және жүйелілік
- ❖ Оқушының жеке тәжірибесіне сүйену
- ❖ Практикалық нәтижеге бағдарлану

4. Бағалау жүйесі

- ❖ Формативті бағалау: пікірталас, постер, тезис, күнделік, эссе
- ❖ Жиынтық бағалау: зерттеу жобасы, презентация, хикмет талдауы [2].

Практикада қолдану

Авторлық бағдарлама жалпы білім беретін мектептің 8-9 сыныптарында бір оқу тоқсаны бойы тәжірибеде тексерілді. Оқу процесі сабақ, тренинг, зерттеу жобалары, шығармашылық шеберханалар түрінде ұйымдастырылды.

1. Сабақ үлгілері

- «Қожа Ахмет Ясауи өмірі» сабағында оқушылар үш дереккөзді салыстырмалы талдап, тарихи контекст картасын құрастырды.
- «Диуани хикмет» талдауы сабағында хикметтен алынған үзінділер бойынша топтар мазмұндық карта жасап, тәрбиелік мәнін ашты.
- «Ясауи кесенесі – сәулет өнерінің жауһары» сабағында 3D модельдеу арқылы кесене құрылымының ерекшеліктері зерттелді.



2. Оқушылардың зерттеу жобалары

Тақырып	Жоба форматы	Нәтижесі
Ясауидің рухани ілімі және қазіргі жастар	Мини-фильм (5 минут)	Мектеп сайтында жарияланды
Хикметтердің тілдік ерекшелігі	Шағын ғылыми жоба	Қалалық конференцияда жұлде
Ясауи кесенесі: цифрлық экскурсия	VR тур	STEM апталығында көрсетілім

3. Нәтижелерді талдау

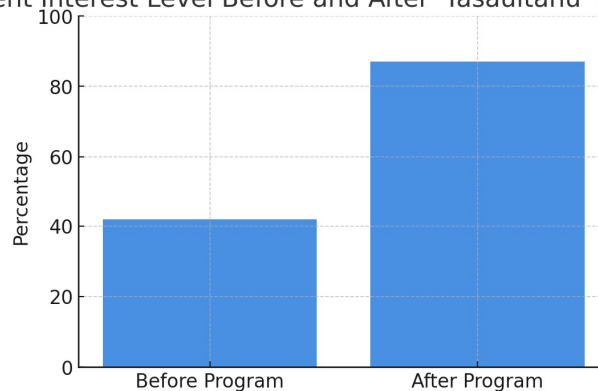
Оқушылармен жүргізілген сауалнама қорытындылары төмендегідей:

Диаграмма (мәтіндік формат)

Оқушылардың пәнге қызығушылығы (%):

- Бағдарламаға дейін – 42%
- Бір тоқсаннан кейін – 87%

Student Interest Level Before and After 'Yasauitanu' Program (%)



Кесте: Құзыреттердің даму деңгейі

Құзырет	Бастапқы деңгей	Қорытынды деңгей
Сыни ойлау	56%	82%
Зерттеу дағдысы	48%	79%
Рухани-адамгершілік түсінігі	60%	90%
Коммуникация	65%	88%

Артықшылықтары:

- ✓ оқушылардың рухани мәдениетін байытады;
- ✓ зерттеу, талдау, шығармашылық қабілеттерін дамытады;
- ✓ хикметтерді қазіргі өмірмен байланыстыруға мүмкіндік береді;
- ✓ пәнаралық байланыс (тарих, әдебиет, өнер, информатика).

Кемшіліктері:

- ✓ кей хикметтердің тілдік күрделілігі түсіндіруді қажет етеді;
- ✓ кей мектептерде ресурстық база (VR, цифрлық құралдар) жеткіліксіз;
- ✓ бағдарламаны толық меңгеру үшін мұғалімнің арнайы дайындығы қажет.

Ұсыныстар

«Ясауитану» бағдарламасын табысты енгізу үшін төмендегі ұсыныстар беріледі:

1. **Мұғалімдердің даярлығы:** Ясауи мұрасы бойынша арнайы курстар, семинарлар өткізілуі қажет. Мұғалімдер хикметтерді түсіндірудің әдіс-тәсілдерін меңгергені дұрыс.
2. **Цифрлық ресурстарды қолдану:** Ясауи кесенесінің 3D модельдері, аудио-хикметтер, виртуалды экскурсиялар сабақ сапасын арттырады.
3. **Бағалау формаларын әртараптандыру:** Эссе, портфолио, постер, зерттеу жобалары оқушылардың қызығушылығын арттырады.
4. **Пәнаралық интеграция:** Хикметтерді әдебиет сабағында көркем мәтін ретінде, тарих сабағында мәдени мұра ретінде, информатикада цифрлық модельдеу тапсырмалары ретінде қолдануға болады.
5. **Оқу топтарына бейімдеу:** Оқушылардың жас ерекшеліктеріне қарай хикметтердің күрделі деңгейін жеңілдетіп, үлестірмелі материалдар дайындау ұсынылады.
6. **Жергілікті мәдени орталықтармен байланыс:** Музейлер, тарихи нысандар, мәдени орындармен бірлескен іс-шаралар тиімділікті арттырады [3].

Қорытынды

Жүргізілген зерттеу нәтижелері «Ясауитану» авторлық бағдарламасының 8-9 сынып оқушыларының рухани, мәдени, танымдық дамуына айтарлықтай оң әсер еткенін көрсетті. Бағдарлама оқушылардың тарихи санасын қалыптастыруға, адамгершілік құндылықтарды бойына сіңіруге, сыни ойлау мен шығармашылық дағдыларын дамытуға мүмкіндік береді. Сабақтардың интербелсенді тәсілдермен, заманауи цифрлық құралдармен ұштасуы оқыту үдерісін жандандырып, пәнге қызығушылықты арттырды.

Бағдарламаны практикада қолдану педагогикалық қауымдастыққа Ясауи мұрасын жаңа форматта оқытудың тиімді үлгісін ұсынады. Бұл бағыттағы жұмыстарды одан әрі жетілдіру, ғылыми-әдістемелік сүйемелдеуді күшейту, цифрлық контентті кеңейту – болашақ міндеттер

болып табылады.

Қорытындылай келе, «Ясауитану» бағдарламасы – оқушылардың рухани дамуын қамтамасыз ететін, ұлттық тәрбиеге негізделген, мазмұны бай, әдістемелік тұрғыдан тиімді педагогикалық жоба. Оның білім беру жүйесіндегі маңызы зор және болашақта кеңінен қолдануға лайық.

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Ясауитану (8-9 классы)

(Применение авторской программы на практике и результаты исследования)

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Учитель истории

Аннотация. В статье анализируются содержание, методологические основы и результаты применения авторской программы «Ясауитану», предназначенной для учащихся 8-9 классов. Программа направлена на развитие духовно-нравственных ценностей и формирование историко-культурного сознания школьников через изучение наследия Ходжи Ахмета Ясауи. В работе описываются педагогические технологии, использованные при реализации программы, примеры уроков, результаты проектных работ и научно-практическая оценка эффективности методики. Кроме того, показана роль авторской программы в повышении интереса учащихся, а также в развитии их исследовательских и критико-аналитических навыков. Полученные в ходе практической работы результаты подтверждают, что данная методика может эффективно применяться в образовательном процессе.

Ключевые слова: Ясауитану, духовное воспитание, ценности, авторская программа, 8-9 классы, методика, педагогический опыт.

Yasawitanu (Grades 8-9)

(Application of the author's program in practice and research results)

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History teacher

Abstract. This article analyzes the content, methodological foundations, and practical outcomes of the author's program «Yasawitanu», developed for students of grades 8–9. The program aims to foster students' spiritual and moral values and to develop their historical and cultural awareness through the study of Khoja Ahmed Yasawi's heritage. The article describes the pedagogical technologies applied during the implementation of the program, sample lessons, project work outcomes, and a scientific-practical evaluation of the program's effectiveness. Additionally, the role of the program in increasing students' interest, as well as in enhancing their research and critical thinking skills, is clearly demonstrated. The results obtained from practical application confirm that the methodology can be effectively integrated into the educational process.

Keywords: Yasawitanu, spiritual education, values, author's program, grades 8–9, methodology, pedagogical practice.

Culturology

Azərbaycan-Fransa mədəni əlaqələrinin əsas istiqamətləri

Əkbərova Əsmayə Bəxtiyar qızı

Baş müəllim, "Dillər və onların tədrisi texnologiyası" kafedrası, ADPU-nun Şəki filialı, Azərbaycan, Orcid id: 0000-0001-9970-0602

Abstract:

Azerbaijan - France Cultural Relations, which have more than three hundred years of history, have made it possible for both peoples to get to know each other better and become closer. Historical cultural foundations, interethnic cultural and humanitarian relations have led to the rapprochement of these nations, the emergence of mutual understanding and intercommunication. Historically, playing the role of a "golden bridge" between East and West has made Azerbaijan one of the most valuable countries in the world in terms of cultural heritage. This has a significant impact on the establishment and expansion of international cultural relations. Our progressive-minded intellectuals have always carried out extensive propaganda work in the field of introducing Azerbaijani culture to the world. Azerbaijani culture at all times of history has been in the center of attention of the leading states of the world civilization, including France, which is considered the cradle of culture of the West. Nizami Ganjavi has been registered since XIV century (1362-1366) "

Key words:

French literature, researchers, Azerbaijani youth, French intelligentsia, historical traditions, treasury of world literature.

1. Giriş:

"Müsyö Jordan və Dərviş Məstəli şah" komediyası Fransaya, fransız ədəbiyyatına, Fransa inqilabına dərin hörmətin təcəssümüdür. M.F.Axundzadənin 1874-1878-ci illərdə Brüssel Universitetində oxuyan oğlu Rəşidbəy Axundov fransız dilini gözəl bildiyindən atasının məsləhəti ilə "Müsyö Jordan və Dərviş Məstəli şah" əsərini fransız dilinə, "Balaca Parislinin həyatı" əsərini isə Azərbaycan dilinə tərcümə etmişdir. Məmməd Arif yazırdı: "Fransız tədqiqatçıları M.F.Axundzadəni rus xalqının Qoqolu, Fransanın Molyeri adlandırır, hətta, fəlsəfi fikirlərinə görə onu dahi fransız filosofu Volterlə müqayisə edirlər." Hələ XIX əsrin sonu-XX əsrin əvvəllərində Avropada təhsil alan Azərbaycan gəncləri, ziyalıları Fransa mədəniyyəti, incəsənəti ilə dərinləndirən maraqlanırdılar. Avropanın mədəni nailiyyəti kimi bu dəyərlərin Azərbaycan mədəniyyətinə inteqrasiyası üçün çalışırdılar.

Fransanın mədəniyyət və incəsənət tarixinin qabaqcıl ziyalıları da Azərbaycan mədəniyyətinə biganə qalmamış, Azərbaycanın tarixi ənənələri, təbiəti, incəsənəti, dəyərli mütəfəkkirləri ilə tanış olmuşlar. Dünya ədəbiyyatı xəzinəsinə dərin töhfələr vermiş, həm də səyyah kimi tanınmış məşhur fransız yazıçısı Aleksandr Dümanın Azərbaycan haqqında xoş xatirələri böyük maraqla qarşılanır. Azərbaycan, onun təbiəti və insanları yazıçının ürəyində dərin izlər qoymuş, yazıçı "Nə olaydı, mənə bir də o yerlərə getmək qismət olaydı!" - demişdir. "Qafqaza səyahət" kitabında xalqımızın təbii sərvətləri, tarixi abidələri haqqında maraqlı məlumatlar verən yazıçı, eyni zamanda azərbaycanlıların həssas, mehriban, zəkali, qayğıkeş, qonaqpərvər, sözübütöv, mərd, işgüzar, yaraşlı, gözəl olduqlarından xüsusi bəhs edir. Dümanın Azərbaycan

haqqında müsbət fikirlərinin formalaşmasında Xan qızı Natəvanın rolu danılmazdır. Dümaya görə "elə xalqların adamları var ki, öz əli ilə imza qoyduğu, möhür vurduğu sənəddən belə boyun qaçırır. Azərbaycanlılarda isə kişi sözü var. Onlarla bir şey barədə sövdələşəndə sənəd, imza, möhür tələb etmək lazım deyil. Azərbaycanlılar verdiyi sözdən heç vaxt dönməz". Azərbaycan dilinin əhəmiyyətindən söz açdıqda isə o demişdir: "Avropada fransız dili necə əhəmiyyətlidirsə, Qafqazda da Azərbaycan dili o cür əhəmiyyətlidir".

Dünya şöhrətli digər bir fransız yazıçısı Jül Vernin "Klodius Bombarnak" kitabında müəllif qəhrəmanın diliylə Azərbaycanın təbii mənzərəsinə heyran qaldığını, aşiq olduğunu söyləmişdir. Azərbaycan-Fransa mədəni əlaqələrinin təşəkkülündə M.A.Şahtaxtinski, C.Hacıbəyov və Ə.Topçubaşovun xidmətləri xüsusi qeyd edilməlidir. Təhsilini Fransada alan Şahtaxtinski, C. Hacıbəyov Azərbaycan tarixi və mədəniyyəti ilə bağlı kitablarını məhz fransız dilində çap etdirmişlər. 1911-ci ildə "Kaspi" qəzetində "Azərbaycan günləri" adlı məqaləsini dərc etdirən C.Hacıbəyov sonradan onu ayrıca kitab şəklində fransız dilində Parisdə nəşr etdirmişdir.

2. Əlaqələrin inkişaf yolu.

1918-ci ildə Azərbaycan Xalq Cümhuriyyətinin yaradılması ilə Azərbaycan-Fransa münasibətləri rəsmi status qazanır. Azərbaycan nümayəndə heyətinin Fransaya ilk səfəri 1919-cu ildə Paris şəhərində keçirilən Paris Sülh Konfransı zamanı baş tutur. Paris Sülh Konfransında əldə edilən diplomatik uğurun nəticəsi olaraq 1920-ci ilin əvvəllərində Bakıda Fransanın nümayəndəliyi açılır. Azərbaycan Xalq Cümhuriyyətinin maliyyə yardımı ilə 100 nəfərə yaxın tələbə Avropa ölkələrinə təhsil almağa göndərilir ki, onlardan 42 nəfəri Fransanın müxtəlif şəhərlərində təhsil almışdılar. AXC-nin süqutu nəticəsində mühacirlərin çox hissəsinin Fransaya üz tutması Azərbaycan-Fransa mədəni əlaqələrinin inkişafına təsirsiz ötüşməmişdir.

Fransada mühacirətdə olan azərbaycanlılar mədəni əlaqələrin inkişaf etməsinə ciddi təşəbbüskarlıqla yanaşaraq, ölkədə Azərbaycan mədəniyyətini tanıتماğa səy göstərirdilər. 1925-ci ildə Parisdə fransız dilində "Arşın mal alan" komediyası tamaşaya qoyuldu. Komediyanı fransız dilinə Ceyhun Hacıbəyli tərcümə etmişdi. Parisdə "Azərbaycan" adlı jurnalın nəşr edilməsi də mühüm mədəni hadisələrdən biri idi. Jurnal "Müsavət" partiyasının nəşri kimi 1926-cı ilin oktyabrından çapa başlamışdı. 1925-ci ilin 4 iyununda Parisdə təhsil alan azərbaycanlı tələbələrin səyi nəticəsində şəhərin Femia Teatrı səhnəsində də fransız dilində "Arşın mal alan" komediyası təkrar tamaşaya qoyuldu. Parisdə İren xanım kimi tanınan Ümmül Banunun Fransa-Azərbaycan mədəni əlaqələrinin formalaşmasında xüsusi rolu olmuşdur. Azərbaycan Xalq Cümhuriyyəti hökumətinin ticarət naziri Mirzə Əsədullayevin qızı Ümmül Banu hələ 19 yaşında ikən (1924-cü ildə) Fransaya getmişdi. Fransızca yazan müəllif xalqı, doğma mədəniyyəti haqqında avropalıları məlumatlandırır. Onun "Qafqaz günləri", "Yad Fransa", "Paris günləri" əsərləri fransızlara çox yaxşı məlumdur.

Lakin Sovet hakimiyyətinin kapitalist dövlətlərlə "çərçivələnmiş siyasəti" Fransa ilə mədəni əməkdaşlıqda da özünü bariz şəkildə göstərirdi. Sovet hakimiyyətinin ilk çağlarında Azərbaycan - Fransa mədəni əlaqələri sahəsində yazıçılarla görüş, mübadilə formalarına daha çox üstünlük verilirdi. Məşhur fransız yazıçısı Anri Barbüsün 1927-ci ildə Azərbaycana gəlişi Azərbaycan-Fransa mədəni əlaqələrinin yeni kontekstdən inkişafında mühüm rol oynadı. Bakı haqqında təəssüratlarını gorkəmli yazıçı özünün "Neft ölkəsində" adlı məqaləsində bu şəkildə ifadə etmişdir: "Əgər məndən sovet hakimiyyətinin həyata keçirdiyi, yaratdığı ən təəccüblü, heyranedicilik işləri haqda soruşsalar, onda mən belə cavab verərdim: Bakıya baxın!". Fransanın ictimai xadimi Andre Malro da Fransanın mədəniyyət işləri üzrə dövlət naziri kimi Azərbaycan - Fransa arasında mədəni əməkdaşlığın hökumətlərarası və dövlətlərarası səviyyədə inkişafına mühüm töhfələr vermişdi. Əhmədiyyə Cəbrayilov, Mirzəxan Məmmədov, Hüseyn Rza Məmmədov və bunlardan başqa 30-a yaxın həmyerlimizlə fransız əsgərləri arasındakı hərbi işgüzar münasibətlər II Dünya müharibəsindən

sonra hər iki ölkənin siyasi, iqtisadi, eləcə də mədəni əlaqələrinin davam etdirilməsinə çox böyük təsir göstərmişdir. II Dünya müharibəsindən sonra Fransada Azərbaycan, onun qədim mədəniyyətinin öyrənilməsinə maraq gücləndi. Elə bu illər Fransanın "Vedi Kartlisa" adlı jurnalında Azərbaycan ensiklopediyasının nəşri haqqında məlumat yayılmışdır.

3. Fransa - Azərbaycan əlaqələrinin dinamik inkişafı.

Tarixi faktlar Azərbaycan-Fransa mədəni əlaqə elementlərinin qədim olduğunu sübut etsə də, bu əlaqələrin dinamik inkişafı yeni tarixi dövrdə baş tutmuşdur. İkitərəfli əlaqələr çoxsaylı səfərlərlə zəngindir. Fransa Azərbaycanın müstəqilliyini tanıyan ikinci dövlətdir (31 dekabr 1991-ci il) və öz səfirliyini Bakıda 1992-ci ildə açmışdır. Mərhum Prezidentimiz Heydər Əliyev və Prezident İlham Əliyev prezident kimi ilk ikitərəfli səfərlərini məhz Parisə etmişdir. Azərbaycan Fransanın Cənubi Qafqazda əsas ticarət tərəfdaşdır. Fransa ilə ticarət dövriyyəimiz iki milyard dollara yaxınlaşır. Azərbaycanın ilk milli telekommunikasiya peykinin orbitə buraxılması Fransa ilə Azərbaycan arasında kosmik əməkdaşlığın da yaranmasına təkan vermişdir. "Azerspace-1" peyki Fransanın Arianespace şirkəti tərəfindən Fransız Qvianasında yerləşən Kuru Kosmodromundan Ariane-5 raketdaşıyıcısı ilə orbitə çıxarılmışdır.

Son illər Fransa ilə Azərbaycan arasında mədəni-humanitar əlaqələr yeni səviyyəyə yüksəlib. Bu əlaqələrin inkişafında Azərbaycanın tərəqqisi, mədəniyyətinin inkişafı və tarixinin tanınması istiqamətində misilsiz fəaliyyət göstərən Heydər Əliyev Fondunun rolu danılmazdır. Məhz yarandığı andan etibarən Fondun məqsədyönlü fəaliyyəti nəticəsində Azərbaycan həqiqətləri bu gün dünya ölkələrində yayımlanır, ölkəmizin siyasi, ictimai, mədəni mənzərəsi yüksək səviyyədə təbliğ edilir. Bu gün Fransanın ali məktəblərində yüzlərlə azərbaycanlı tələbə təhsil alır, bir çox Fransa universitetlərində Azərbaycan dili və tarixi tədris olunur. Eyni zamanda, Azərbaycanın paytaxtı Bakıda fransız liseyi fəaliyyət göstərir. Azərbaycan dövləti Luvr muzeyində İslam incəsənəti departamentinin yaradılmasında iştirak etmişdir. Heydər Əliyev Fondu Luvr, Versal Sarayı, Strasburq Kafedral Kilsəsi və digər bir çox tarixi abidələrin bərpasında xüsusi rol oynamışdır. Azərbaycan mədəniyyətinin Fransada tanınmasına, milli-mənəvi dəyərlərimizin təbliğinə həsr etdiyi davamlı tədbirlər olduqca əhəmiyyətlidir. Heydər Əliyev Fondunun dəstəyi ilə Fransanın paytaxtında və iyirmidən çox şəhərində Qafqazın mirvarisi olan Azərbaycanın mədəniyyətini təmsil edən sərgilər, konsertlər və digər tədbirlər keçirilib. Parisdə dahi Azərbaycan şairləri Nizami Gəncəvi və Məhsəti Gəncəvinin həyat və yaradıcılığına həsr olunmuş elmi konfranslar keçirilib. Miluz şəhərinin Yuxarı Alzas Universitetinin filologiya fakültəsinin konfrans zalı Heydər Əliyev Fondunun dəstəyi ilə tamamilə yenidən qurulub və zala Məhsəti Gəncəvinin adı verilib. Fond tərəfindən Fransanın müxtəlif bölgələrində mədəniyyətimizi tanıdan Azərbaycan günləri keçirilməkdədir. Bu layihə çox böyük uğurla Reyms və Şampan şəhərlərində başlayıb və hər il də ənənəvi şəkildə davam edir.

2012-ci ildə Parisdə Azərbaycanın ilk mədəniyyət mərkəzinin binası istifadəyə verildi. Belə bir mərkəzin ilk dəfə məhz Parisdə açılması təsadüfi seçilməmişdi. Çünki Paris tək-cə Fransanın yox, demək olar, bütün dünyanın mədəniyyət paytaxtıdır. Parisin mərkəzində - Eyfel qülləsinin yaxınlığında yaradılan Azərbaycan Mədəniyyət Mərkəzi ölkəmizin dünya mədəniyyətinin paytaxtında təbliğ olunması istiqamətində atılan ən mühüm addımlardan biridir. Xüsusi əhəmiyyəti ilə seçilən bu mərkəz mədəniyyətlərarası və sivilizasiyalararası dialoq nöqtəsi kimi seçilən Azərbaycanın ən yüksək səviyyədə tanınmasına xidmət edir. Ölkəmizin qədim və zəngin tarixinə, mədəniyyətinə dair eksponatların bir məkanda təqdim edildiyi mərkəz Azərbaycanın mədəni tanıtımı baxımından fəaliyyətin rəsmiləşdirilməsinə də böyük imkanlar açır. Heydər Əliyev Fondunun təşkilatçılığı ilə keçirilən Azərbaycan Mədəniyyət Günləri çərçivəsində hər il dünyanın ən seçilən festivallarının təşkilatçısı olan, yüz minlərlə turistin ziyarət etdiyi Kann şəhəri tarixi zəngin mədəniyyətimizin nümayişinə ev sahibliyi edir. Özündə antik və müasir dövrün sintezini yaşadan Azərbaycan incəsənəti fransızlara təqdim olunur. Bu tədbir dünya mədəni irsinə əvəzəlməz töhfələr vermiş Azərbaycan mədəniyyətinin tanınması və təbliği baxımından

əhəmiyyətli rol oynayır. Dünya mədəni irsinin ayrılmaz tərkib hissəsi olan Azərbaycan muğamı və klassik musiqilərimiz daim Fransa musiqisevərlərinin diqqət mərkəzində olmuşdur. 1999-cu ildə Fransada keçirilən Beynəlxalq festivalda Azərbaycan Dövlət Simfonik orkestrinin (bədi rəhbər və dirijor, xalq artisti R.Abdullayev) ifasında Ü.Hacıbəyov, Q.Qarayev və F.Əmirovun əsərləri uğurla ifa edilmişdir. Fransanın İl-de Frans regionu tərəfindən 1976-cı ildən etibarən keçirilən məşhur mahnı festivalı ənənəvi xarakter daşıyır. 2013-cü ildən sentyabrın 7-dən oktyabrın 13-dək davam edən festivalda muğamlarımızın və xalq mahnılarımızın Alim Qasimov və Fərqanə Qasimovanın ifasında tamaşaçılar tərəfindən həvəslə dinlənilməsi muğamımızın Fransada kifayət qədər tanınmasının, muğama olan rəğbətə göstəricisidir. Hər il Heydər Əliyev Fondu tərəfindən Fransanın ayrı-ayrı şəhərlərində təşkil olunan Azərbaycanın klassik musiqi gecələri də böyük marağa səbəb olur.

Nəticə:

Son illər ərzində Azərbaycanın və Fransanın 12 şəhəri arasında əməkdaşlıq və dostluq haqqında saziş imzalanıb. Belə əlaqələr ölkələrimizi, xalqlarımızı daha yaxşı tanımağa imkan yaradır, iqtisadi və humanitar sahələrdə əlaqələrin inkişafı üçün yeni imkanlar açır. 2011-ci ildə keçmiş Fransa Prezidenti Nikola Sarkozinin ölkəmizə rəsmi səfəri çərçivəsində Azərbaycanın birinci xanımı Mehriban Əliyevanın Fransa Respublikasının “Şərəf Legionunun Zabiti” dövlət ordeni ilə təltif olunması bütövlükdə Azərbaycan-Fransa humanitar mədəni əlaqələrinin qiymətləndirilməsi idi. Milyonlarla ziyarətçisi olan Luvr muzeyinin qarşısındakı məşhur “Pale Royal” meydanında “Azərbaycan şəhərciyi”nin təşkili həm Paris sakinləri, həm də bu şəhərə gələn turistlərin ölkəmiz haqqında dolğun məlumat ala bilməsinə imkan yaradır.

Şəhərciyin təşkilində əsas məqsəd Azərbaycanın xaricdə daha yaxşı tanınmasını, Fransada və onun paytaxtında bununla bağlı təbliğat xarakterli tədbirlərin davamlılığını təmin etməkdir. Mehriban xanım Əliyevanın rəhbərliyi ilə Fond tərəfindən bir çox genişmiqyaslı layihələrin həyata keçirilməsi milli mədəniyyətimizin inkişafını intensivləşdirərək mənəvi irsimizin mühafizəsinə, Azərbaycan mədəniyyətinin özünəxas unikallığının qorunmasına və bütün dünyada tanınmasına töhfə verir. Xüsusilə, erməni lobbisinin üstünlük təşkil etdiyi, anti-azərbaycan təbliğatının güclü olduğu Fransada belə mötəbər tədbirlərin həyata keçirilməsi Azərbaycanın real və qərəzsiz tanınmasına imkan yaradır. Çünki ən yaxşı təsir vasitəsi məhz mədəni təbliğdir. Heç bir sərhəd və çərçivəyə sığmayan mədəniyyət müxtəlif əqidəli və irqli insanları bir yerə toplayan ən yaxşı ünsiyyət vasitəsidir. Ölkəmizin zəngin mədəniyyəti və incəsənəti Azərbaycanın dünyada layiqincə tanınmasına imkan yaradır.

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ЖЕНСКАЯ ИНИЦИАЦИЯ КАК НАРРАТИВНАЯ СТРУКТУРА В РОМАНЕ Ж. АЙМАУЫТОВА «АҚБІЛЕК»

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Аннотация. Данная статья посвящена исследованию женской инициации как нарративного и культурного механизма в романе Жусупбека Аймауытова «Ақбілек». Проанализированы этапы трансформации героини через призму ритуальной модели.

Цель исследования заключается в комплексном анализе этапов формирования женской идентичности, представленных в произведении, а также в выявлении механизмов, с помощью которых автор через символические и ритуальные образы передает процесс внутренней трансформации главной героини. Статья сочетает литературоведческий анализ с элементами гендерной критики и опирается на теоретические концепции В. Тернера, А. ван Геннепа.

В работе рассматриваются структурные и семантические элементы сюжета, способствующие осмыслению женской инициации как акта перехода от традиционного патриархального уклада к современному самосознанию и эмансипации.

Актуальность исследования заключается в том, что роман «Ақбілек» является одним из первых произведений казахской литературы, в котором женская судьба рассматривается не как объект традиционных норм, а как самостоятельный путь внутреннего взросления, преодоления социальной травмы и поиска идентичности. Его анализ через призму инициации, гендерной теории и постколониального контекста позволяет глубже понять, как в условиях исторических потрясений формируется новая модель женского субъекта в национальном нарративе.

Исследование впервые интерпретирует трансформацию героини как инвертированную модель женской инициации, обусловленную колониальным насилием и социальной стигматизацией, что расширяет современные подходы к казахской гендерной прозе 1920-х гг.

Данная статья демонстрирует, как процесс женской инициации в романе «Ақбілек» служит не только для художественного изображения личностного обновления, но и отражает общественные трансформации, влекущие за собой переосмысление гендерных ролей в переходный исторический период.

Ключевые слова: Ақбілек, Жусупбек Аймауытов, женская инициация, казахская литература, гендерная идентичность, нарратив, лиминальность

Материалы и методы исследования

Основным материалом является текст романа Ж. Аймауытова «Ақбілек».

В работе применяются методы структурного и нарративного анализа, а также сравнительно-культурные и гендерные подходы для выявления особенностей женской инициации в произведении.

Применение этих методов позволяет рассмотреть художественную трансформацию героини не только в рамках фабулы, но и как социокультурную репрезентацию женского становления в условиях общественного давления и личной травмы.

Введение

Роман Ж. Аймауытова «Ақбілек» представляет собой ключевой текст казахской прозы 1920-х годов, в котором поднимаются вопросы социальной трансформации, гендерных ролей и национальной идентичности в контексте постколониального кризиса. Особое внимание в данной работе уделяется феномену женской инициации, понимаемой как комплексный переход от одного жизненного статуса к другому, сопровождаемый физическими, социальными и психологическими испытаниями. В романе этот переход представлен четырьмя основными частями: «Ақбілек», «Рана», «Тоска», «Любовь», каждая из которых соответствует этапам ритуального перехода согласно классификации А. ван Геннепа – отделению, переходу и возвращению. Анализ осуществляется с опорой на нарративную структуру и культурный контекст.

Роман «Ақбілек» впервые был опубликован в журнале «Әйел теңдігі» («Равноправие женщин») в 1927 году (№ 2, 5, 10, 11) и в 1928 году (№ 3, 4, 9, 10). Однако при жизни автора произведение так и не вышло. Позднее роман был напечатан в журнале «Жұлдыз» (1989, № 6–9) и включён в первый том пятитомного собрания сочинений писателя.

Некоторые сведения о романе можно найти в переписке между М. Ж. Көпеевым и Ж. Аймауытовым. Значимость этих писем заключается в том, что они раскрывают творческую историю создания «Ақбілек» и содержат ценные авторские размышления. В одном из писем Аймауытов отмечает, что работа над романом полностью поглотила его мысли и напряжённый режим письменного труда, более двух месяцев. Завершив рукопись, автор направил её в печать. Для исследователей это свидетельство имеет особую ценность, позволяя реконструировать процесс создания произведения и его внутреннюю мотивацию.

Переписка с М. Ж. Көпеевым также отражает стремление Аймауытова собирать, издавать и распространять национальное литературное наследие, что свидетельствует о его глубокой вовлечённости не только в художественную, но и в просветительскую и культуросохраняющую деятельность.

Степень разработанности темы показывает, что роман «Ақбілек» неоднократно становился объектом внимания литературоведов. В работах С. Қирабаева, Т. Кәкішұлы, Р. Нұрғали, Б. Майтановой произведение рассматривается преимущественно в контексте социально-бытового конфликта, кризиса традиционного уклада и реалистической поэтики 1920-х годов. Исследования акцентируют внимание на психологической достоверности образа героини и исторической обусловленности сюжета. Однако анализ романа через призму теории ритуала, концепции инициации, а также гендерных и постколониальных подходов остаётся фрагментарным. Недостаточно изучено, как нарративная структура формирует опыт женской трансформации и какие культурные механизмы лежат в основе этого перехода. Настоящее исследование направлено на восполнение данного пробела.

Исследователи единодушно признают, что «Ақбілек» – это не просто художественное произведение, но роман, основанный на реальных событиях. В воспоминаниях современников содержатся конкретные исторические случаи, связанные с трагической судьбой девушек периода гражданской смуты, что придаёт произведению особую

документальную глубину и усиливает социально-психологическую убедительность образа героини.

Результаты и обсуждение

В ходе анализа романа «Ақбілек» выявлено, что структура женской инициации в тексте строится на глубокой трансформации героини, развернутой в четырехчастной композиции, каждая из которых соответствует стадиям переходного ритуала в терминах В. Тернера и А. ван Геннепа: отделение, лиминальность, маргинальность, реинтеграция.

В мифологических и культурных традициях инициация символизирует переход героя к новому состоянию – его «перерождение». Эту концепцию подробно исследовали М. Элиаде и Дж. Кэмпбелл, подчеркивая её универсальность и символическую глубину.

Однако Аймауытов, переосмысляя традиционные этапы, предлагает нестандартную, травматическую инициацию, вызванную не ритуалом, а историческим и социальным насилием.

1. *Инициация как разрушение традиционного перехода*

В первой части романа, соответствующей стадии отделения (по А. ван Геннепу), героиня изображена как представительница традиционного казахского женского идеала – «Ақбілек». Её готовят к замужеству, она следует ожиданиям семьи. Однако традиционный переход прерывается насильственным вмешательством извне: героиня похищается белогвардейцами и подвергается сексуальному насилию: «Үш орыс қызды көтеріп, ойбайлатып алды да жөнелді» (Ж. Аймауытов, стр. 5).

Этот акт следует рассматривать как антиритуал, то есть насильственную, несанкционированную инициацию, не обеспечивающую социальной защиты. В отличие от классической инициации, здесь не происходит культурной легитимации нового статуса; напротив, телесное и символическое «осквернение» становится причиной социального изгнания.

Аймауытов сознательно заменяет культурный ритуал (сватовство, приданое, свадьба) на насильственное событие, тем самым демонстрируя колониальное насилие как разрушитель традиционных женских траекторий.

Таким образом, разрыв с ритуальной структурой подчеркивает кризис традиционной модели инициации, когда общество оказывается неспособным интегрировать посттравматический субъект.

Этот момент можно интерпретировать в свете работ Г. Спивак, утверждавшей, что в условиях колониального и патриархального дискурса женщина оказывается «приглушенным субъектом», чья судьба определяется внешними силами. Ақбілек из «девушки рода» превращается в объект стыда и молчания.

2. *«Рана» – лиминальность, символическая смерть и маргинализация*

Во второй части романа («Рана») Ақбілек возвращается в родное сообщество после похищения белогвардейцами. Однако она сталкивается с полным отчуждением: отец смотрит холодно, мать погибла, возлюбленный Бекболат отвернулся, и только бездетная золовка Уркия проявляет сострадание. Её травма воспринимается не как страдание, заслуживающее сочувствия, а как позор, что приводит к утрате морального капитала, несмотря на то что она была жертвой, а не инициатором насилия.

Этот этап соответствует лиминальной стадии инициации (по Тернеру), когда субъект утрачивает прежнюю социальную роль, но ещё не включён в новую. В случае Ақбілек лиминальность приобретает *травматический* характер: прежнее «я» полностью разрушается. Похищение, насилие и отчуждение означают *символическую смерть* девочки

и дочери, что является необходимой фазой её внутреннего перерождения. В терминах ритуальной теории это близко к концепции *катабасиса* — «нисхождение в мир мёртвых» и возвращение другим человеком. Однако у Акбілек эта смерть *насильственная и социально закреплённая*: сообщество лишает её прежнего статуса и чести.

Возвращение героини происходит как *новой женщины* — мыслящей, самостоятельной и на выбор. Она перестает соответствовать прежним рамкам социальной и гендерной идентичности, что ведёт к *самоконструированию нового «я»*. При этом сообщество отказывается признать её новый статус, что помещает Акбілек на границе социального и культурного поля.

Этот момент подчеркивает гендерную несправедливость традиционного общества, где «честь» женщины рассматривается как общественный ресурс, а не личное достоинство. Лиминальная фаза и травматическое «умирание» девочки позволяют героине *пережить и осмыслить собственное* взросление, что делает её внутренне автономной и готовой к самостоятельной жизни. В рамках анализа Ю. Лотмана такое исключение из символического порядка выводит Акбілек в зону культурной тени, где формируется её новый, зрелый субъект.

Таким образом, в «Рана» Аймауытов демонстрирует уникальную модель женской инициации: не через социальный ритуал, а через насильственное разрушение прежнего «я» и последующее экзистенциальное возрождение, которое превращает девочку в женщину, готовую к самостоятельному существованию.

3. «Тоска» – рефлексия и реконструкция идентичности

Третья часть романа представляет интроспективный этап, в котором героиня замыкается в себе, испытывает одиночество и отстраненность, но начинает внутреннюю работу по формированию новой идентичности. Психоэмоциональное состояние тоски превращается в пространство личного взросления. Именно здесь происходит сдвиг от внешне навязанного статуса к самоконструируемому «я».

Часть романа, в которой Акбілек оказывается в городе у брата Толегена, представляет стадию внутренней инициации, где она восстанавливается не как «чистая» невеста, а как мыслящая, образованная, свободная женщина. Этот процесс можно интерпретировать через концепцию Жудит Батлер: гендерная идентичность не дана раз и навсегда, она перформативна, то есть формируется в действии, выборе и речи.

Акбілек проходит через обучение, признавая своё право на собственный голос. Таким образом, роман разрушает бинарную модель: «или жертва, или изгнанница», предлагая альтернативу – женщину, выстраивающую идентичность вне традиционной морали.

Героиня осознает, что традиционные представления о женской чести и социальной роли являются инструментами контроля, а не моральной истины. Эта стадия приближается к иницирующей смерти старой личности, после которой субъект возрождается не благодаря обряду, а через экзистенциальный выбор. Автор подводит героиню к осознанию своей ценности – не в статусе «девушки» или «жены», а в способности мыслить, чувствовать и действовать независимо.

В интерпретации М. Бахтина эта фаза соответствует внутреннему монологу героини – она вступает в диалог с собой и с социумом. Отсюда рождается новая, синтетическая личность, способная к выбору.

Таким образом, стадия тоски представляет собой момент истинной инициации, но уже не ритуальной, а психологически зрелой, выходящей за пределы традиционного культурного сценария.

4. «Любовь» – возвращение как реинтеграция

Заключительная часть романа демонстрирует героиню, вступившую в новый жизненный этап, символически инициацию. Её брак уже не несет следов патриархального давления: он основан на принятии и диалоге. Акбілек возвращается в социум, но уже как субъект – не как носитель «чести», контролируемой обществом, а как личность с опытом, волей и пониманием.

В терминах В. Тернера это этап реинтеграции – вхождения в новое социальное состояние. Однако, в отличие от традиционной реабилитации через обряд, например, повторную свадьбу или прощение старейшинами, Аймауытов подчеркивает, что героиня достигает нового статуса автономно, за счет внутренней трансформации, а не социальной милости.

Сцена воссоединения с сыном Ескендиром, случайная встреча на улице, сопровождаемая слезами, символизирует психологическое и культурное возвращение. Героиня обретает не просто сына, а право на материнство, ранее отвергнутое обществом. Далее следует брак с Балташем, который, в отличие от Бекболата, принимает её не вопреки, а вместе с прошлым. Балташ становится не только партнером, но и символом новой эпохи – городской, открытой, светской.

Таким образом, финал представляет собой реинтеграцию героини, но не в традиционный уклад, а в модернизированный, гуманистический социум, где женщина обретает новую идентичность. Это завершение соответствует третьей фазе инициации у ван Геннепа – агрегации, но в трансформированном виде. Возвращение происходит не в том виде, в каком ожидалось в начале пути, а как обретение совершенно нового качества личности.

Заключение

Роман Жүсіпбека Аймауытова «Ақбілек» занимает особое место в истории казахской литературы, поскольку представляет женскую судьбу не как объект внешних обстоятельств, а как самостоятельный процесс формирования личности. Аймауытов выводит женщину из статуса «сюжетной функции» в статус субъекта — мыслящего, рефлексирующего и способного к самоопределению, что делает текст по-настоящему новаторским.

Произведения той эпохи, посвящённые женской судьбе, такие как «Бақытсыз Жамал» (1910) М. Дулатұлы, «Қамар сұлу» (1914) С. Торайғырова и «Шұғаның белгісі» (1915) Б. Майлина, отражают социальные, культурные и мировоззренческие конфликты начала XX века и демонстрируют, насколько ограниченными были возможности женского выбора в условиях патриархального уклада. В этих произведениях женские образы чаще всего завершаются трагедией, исчезновением или гибелью, что символизирует невозможность интеграции героинь в кризисное общество. На этом фоне художественное новаторство Аймауытова проявляется особенно ярко.

В «Ақбілек» писатель предлагает инверсивную модель инициации: взросление героини происходит не через традиционный ритуал, а через травму, символическую смерть, социальное отторжение и внутреннюю работу сознания. Пройдя путь утраты, стигматизации и маргинализации, достигает личностной интеграции, что радикально переосмысляет традиционный женский образ в казахской прозе начала XX века.

Таким образом, модель инициации в «Ақбілек» становится метафорой культурной модернизации: новая женщина рождается не через следование традиции, а через преодоление её ограничений. Аймауытов демонстрирует, что обновление общества невозможно без признания женского опыта, женской субъектности и права женщин на собственную историю.

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Biological Sciences

MODERN METHODS AND TECHNOLOGIES IN BIOLOGY EDUCATION: THEIR IMPACT ON STUDENTS' PERSONAL DEVELOPMENT

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Abstract

This bibliographic analysis provides a comprehensive examination of the impact of modern methods and technologies used in biology education on students' personal development. The study includes an analysis of international literature and identifies the relationship between personal development and contemporary instructional methods. The findings emphasize that the influence of biology as a school subject on students' personal development is directly connected to how and in what ways teachers deliver instruction. According to the analysis, the use of critical thinking strategies, digital-innovative methods, as well as project-based and research-oriented activities, positively contributes to students' emotional, social, and intellectual development. Therefore, the effective integration of modern teaching methods in biology education serves as an important tool that enhances students' life competencies and supports their personal development.

Keywords: students' personal development, modern methods, modern technologies, biology education, soft skills

Introduction

Research Relevance. The education system is currently undergoing significant transformations and stages of development. In particular, various innovative methods and digital technologies have been rapidly evolving, bringing substantial benefits to the educational sphere. The primary responsibility of schoolteachers today is not only to provide knowledge but also to contribute to the creative development, growing responsibility, and comprehensive formation of a modern learner. In the contemporary competitive environment, the demand for specialists with well-developed soft skills is steadily increasing (Labov, 2010). Competencies such as teamwork, time management, communication skills, and the ability to collaborate are considered essential for enhancing students' academic achievement, whereas problem-solving and leadership skills are regarded as key soft skills for career advancement (Ferreira, 2020). Soft skills must be developed and strengthened during undergraduate studies; however, in order for these competencies to be effectively formed at the university level, foundational understanding and early development must begin during school years (Christopoulos, 2023). The availability of innovative tools and online platforms has democratized access to information, enabling students to learn anytime and anywhere. The use of various innovative teaching strategies significantly enhances learners' critical thinking, independence, social and communicative competencies. Therefore, investigating

the impact of modern methods and technologies on students' personal development has become a highly relevant direction within contemporary pedagogy and educational science.

Research aims to investigate the impact of modern methods and technologies used in biology education on students' personal development. In particular, to identify the most effective types of soft skills necessary for personality formation and to determine the teaching methods that contribute to the development of these competencies.

Research problem. The range of modern methods and technologies that influence students' personal development in the process of learning biology, as well as their effectiveness, has not been fully explored. Many teachers lack resources and conditions to integrate innovative approaches optimally. Furthermore, the limited availability of modern technologies in rural schools has also become a significant challenge that necessitates further research.

Research questions:

1. Which modern methods and technologies used in teaching biology most effectively contribute to students' personal development?
2. Which teaching strategies can be integrated into the educational process to enhance soft skills?
3. How do the teacher's professional competence and ability to implement modern methods influence students' overall development and personality formation?

Significance of the Study. This study contributes to the growing body of international research on the integration of innovative teaching practices in science education. By focusing specifically on biology instruction, the research highlights subject-specific opportunities for developing students' emotional, social, intellectual, and communicative competencies. The findings are particularly significant for improving educational policy and practice in Kazakhstan, where disparities between urban and rural schools remain a pressing issue. The study provides valuable insights for educators, curriculum designers, and policymakers seeking to enhance soft skills development and to align biology education with the demands of the modern labor market. Moreover, the research underscores the crucial role of teachers' methodological competence in shaping students' holistic development, offering evidence-based recommendations for professional training and instructional improvement.

Literature Review

Personal development is understood as the process through which an individual forms and cultivates distinctive qualities, including character, worldview, and personal values. The development of an individual is primarily shaped by the interplay of upbringing, the social environment, and educational practices (Medeiros et al., 2020). Within this context, contemporary teaching methods refer to pedagogical approaches that foster students' critical thinking, independent learning, and active engagement. Such methods include project-based learning, critical thinking strategies, the flipped classroom model, inquiry-based learning, and modular teaching technologies (Reina, 2022).

A key feature of these methods is their emphasis on learner autonomy: rather than receiving information passively, students are encouraged to acquire knowledge independently. Through activities such as debates, role-playing, group work, discussions, listening tasks, and peer feedback, learners develop essential communicative and social competencies. These approaches also nurture important soft skills, including leadership, tolerance, and empathy (Chen, 2024). Modern pedagogical methods offer numerous advantages, including the enhancement of cognitive engagement, the strengthening of teacher student collaboration, the development of creativity and independent thinking, and the formation of life competencies. However, they also present several challenges, such as increased time requirements, insufficient material and technical resources, and the need for high levels of teacher professionalism. The experience of Nazarbayev Intellectual Schools demonstrates that integrating CLIL, project-based learning,

debates, and digital platforms into the learning process plays a significant role in developing students' metacognitive abilities and personal qualities. Project work and educational games enhance students' responsibility, reflective thinking, and self-confidence, as these methods foster genuine interest and engagement with academic subjects (Diem, 2024).

Contemporary teaching methods influence students' personal development across three dimensions. In the social dimension, learners acquire the ability to interact effectively within society. In the cognitive dimension, they develop the capacity to process and analyze information independently. In the emotional dimension, students experience increased motivation, interest, and positive attitudes toward learning. The relationship between modern teaching methods and personal development is also revealed through three interconnected directions: an informational-cognitive direction that promotes the active acquisition of knowledge and skills; a value-oriented direction that fosters cultural, spiritual, and ethical qualities; and an action-oriented direction that enables students to apply knowledge in real-life problem-solving (Fidiastuti, 2024). Personal development further encompasses self-awareness, the formation of a value system, and the continuous improvement of one's interactions with the surrounding environment. Biology as a school subject holds significant potential in this regard, as it promotes the development of students' worldview, intellectual growth, and moral qualities (Moundy et al., 2022). Through biological education, learners gain an understanding of natural laws, perceive the interconnectedness between humans and the environment, and develop ecological responsibility and ethical attitudes (Moundy et al., 2025). In recent years, interactive, project-based, inquiry-driven, and digital teaching methods have increasingly replaced traditional lecture-style instruction in biology classrooms. These methods not only enhance students' academic engagement but also support key aspects of personal development.

Key contemporary methods in biology education

- *project-based learning*: encourages students to solve real-life biological problems through extended inquiry;
- *inquiry-based learning*: develops scientific thinking and research skills;
- *critical thinking strategies*: strengthen learners' abilities to analyze, justify, and compare biological concepts;
- *ICT and digital platforms*: provide visual models, simulations, and virtual experiments that deepen scientific understanding;
- *game-based and collaborative learning techniques*: foster communication, cooperation, and teamwork.

Collectively, these methods aim to shape students into active, independent, and research-oriented learners in the biology classroom (Moundy et al., 2025).

Methods

A comprehensive literature review was conducted to examine modern methods and technologies used in biology education and their impact on students' personal development. The methodological framework of the study was based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which ensured a transparent, rigorous, and replicable selection process. The primary database used for the literature search was Scopus, due to its extensive coverage of peer-reviewed publications. A series of advanced search queries was applied using combinations of keywords related to the core concepts of the study: "*personal development of students*," "*modern methods*," "*modern technologies*," "*teaching of biology*," and "*soft skills*." The search was restricted to:

- publication years: 2019–2025
- subject area: social sciences
- document type: articles
- language: english

- author keywords: soft skills, higher education, students, emotional intelligence, education, leadership, communication skills, active learning, critical thinking, competencies, soft skills development, project-based learning, empathy, creativity, creative thinking, etc.

Multiple search strings were constructed to capture the widest possible range of relevant studies. Examples of the exact Scopus search queries include:

TITLE-ABS-KEY (“personal development of students”) AND PUBYEAR > 2019 AND PUBYEAR < 2025 AND (LIMIT-TO (SUBJAREA, “SOCJ”)) AND (LIMIT-TO (DOCTYPE, “ar”)) AND (LIMIT-TO (LANGUAGE, “English”)) AND (LIMIT-TO (EXACTKEYWORD, “Soft Skills”) OR ...)

TITLE-ABS-KEY (“Modern methods”) AND PUBYEAR > 2019 ...

TITLE-ABS-KEY (“Modern technologies”) AND PUBYEAR > 2019 ...

TITLE-ABS-KEY (“Teaching of biology”) AND PUBYEAR > 2019 ...

TITLE-ABS-KEY (“Development of soft skills”) AND PUBYEAR > 2019 ...

The PRISMA approach was employed to ensure systematic identification, screening, eligibility assessment, and final inclusion of sources. The overall search initially yielded 288 records. During the automated filtering stage:

- publications were restricted by year (2020 onwards),
- only english-language articles were retained,
- irrelevant subject areas and document types were removed.

Following automated filtering, 116 records remained. During the manual screening stage:

- 5 studies were excluded due to mismatch with the topic based on title and abstract;
- 9 studies were excluded based on insufficient relevance after full-text content analysis;
- 13 studies were excluded due to methodological incompatibility or lack of substantive results aligned with the study aims.

Finally, 89 studies met all inclusion criteria and were incorporated into the review. Figure 1 presents the full PRISMA flow diagram illustrating each stage of the selection process.

PRISMA Framework. The use of the PRISMA methodology ensured: clear justification of inclusion and exclusion criteria, elimination of duplicate or irrelevant articles, transparency and

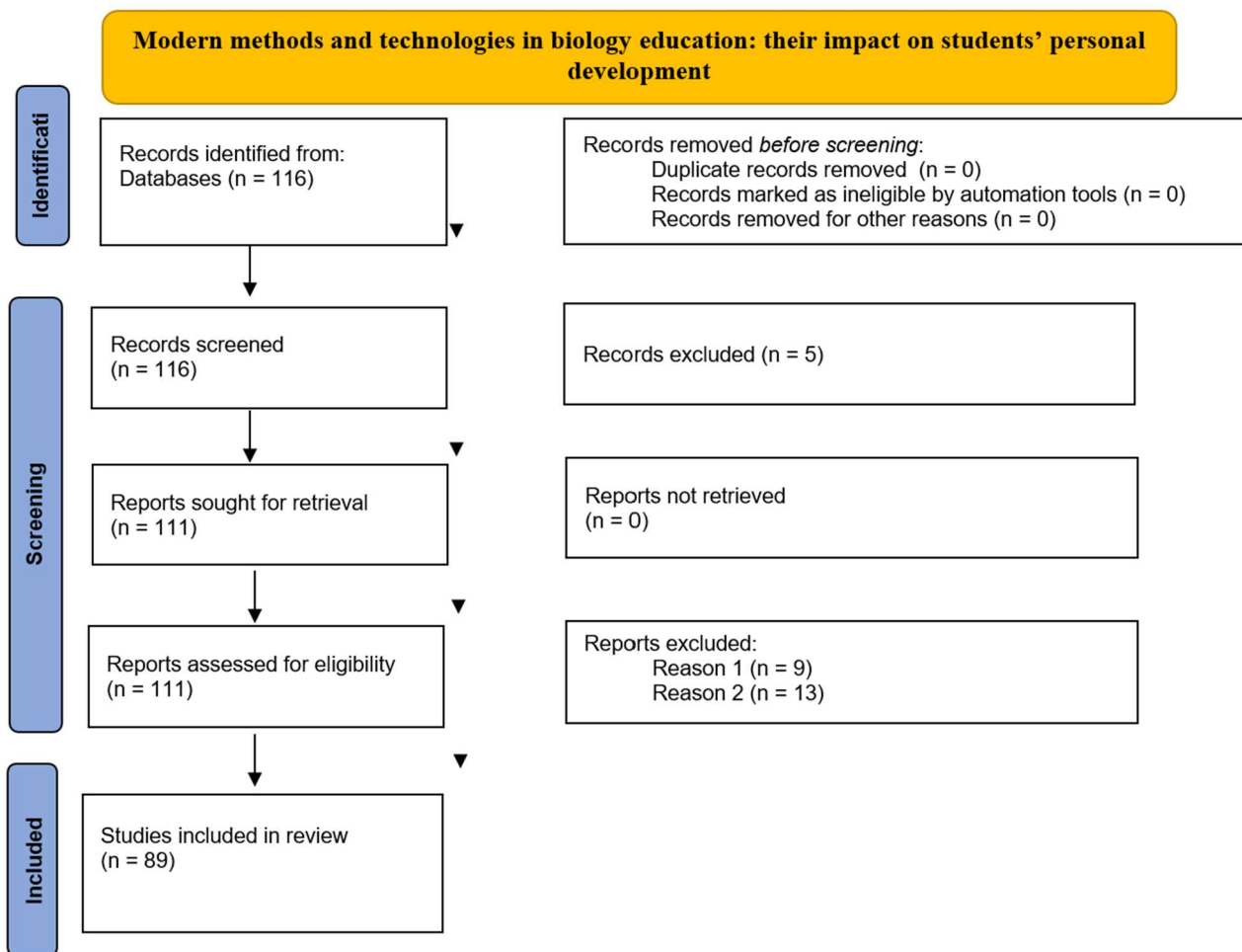


Figure 1. - PRISMA flow diagram of the study selection process for the review on modern methods and technologies in biology education and their impact on students' personal development

reproducibility of the search process, improved validity of the review findings. This systematic approach allowed for a high-quality synthesis of the scientific literature on modern instructional technologies, teaching methodologies in biology, and factors influencing students' personal development and soft skills formation.

Results and Discussion

The analysis of the publication dynamics demonstrates a steady and significant increase in scientific interest related to *soft skills* within the context of modern educational methods. The annual distribution of documents shows that research activity in this area was minimal at the beginning of the analyzed period. In 2020, only five publications were identified that met the inclusion criteria, reflecting relatively low academic engagement with the topic at that time. A notable rise occurred in the subsequent years. By 2022, the number of relevant studies had doubled, reaching approximately ten publications. This growth indicates an expanding recognition of soft skills as critical components of contemporary education, especially within pedagogical and social science research. The most substantial increase was observed in 2024-2025, during which the number of studies surged to approximately 25 publications. This sharp growth reflects a significant shift in scholarly attention toward examining how modern instructional methods such

as project-based learning, digital technologies, inquiry-based approaches, and collaborative learning contribute to the development of students' soft skills. Furthermore, the citation trends reinforce this observation: citations have shown consistent upward growth, indicating not only an increase in the quantity of publications but also their rising influence within the academic community. This suggests that the topic has become a central focus in recent educational research, driven by global demands for competencies such as communication, critical thinking, leadership, creativity, and emotional intelligence.

A geographical analysis of the publication distribution reveals significant variation across countries in terms of scientific engagement with modern methods and technologies in biology education and their connection to students' personal development. As shown in Figure 2, research activity is concentrated primarily in several regions, indicating differing levels of academic investment and prioritization of soft skills development in educational systems. Countries such as Russia and Brazil demonstrate the highest intensity of research output, suggesting a strong institutional interest in innovative pedagogical approaches and their role in shaping learners' competencies. Medium levels of activity are observed in nations such as Mexico, Colombia, South Korea, and India, where modern educational technologies and active learning strategies are increasingly integrated into national educational reforms. Lower levels of research engagement are noted in some parts of Africa, Central Asia, and Oceania, indicating either limited access to educational technologies, fewer research initiatives, or different national research priorities.

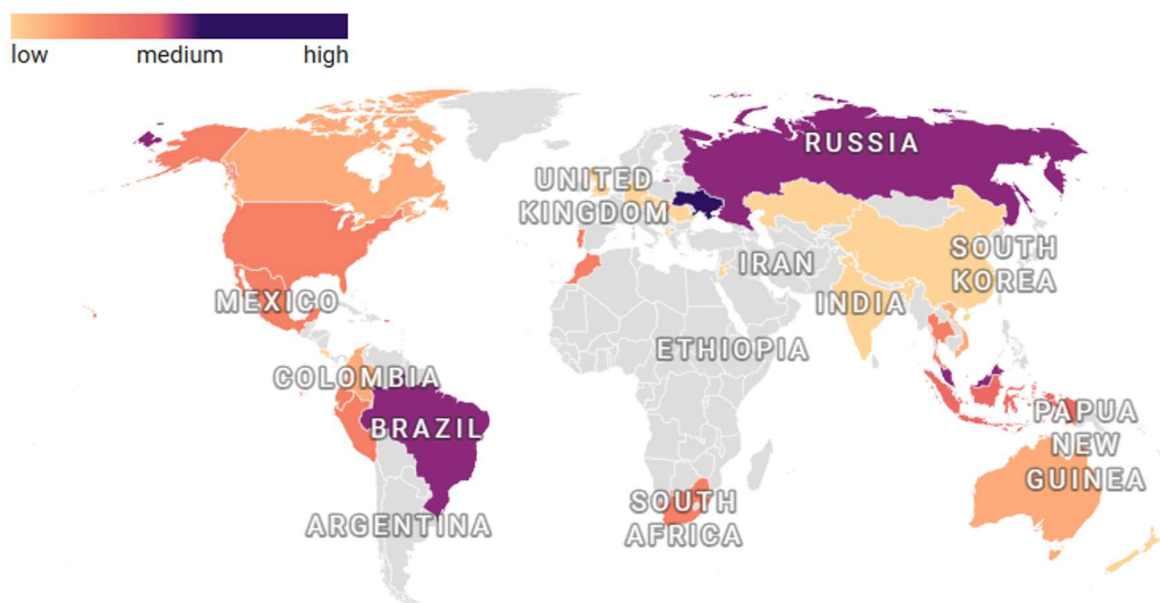


Figure 2. - World distribution of publications on modern methods and technologies in education and soft skills development

The geographical distribution highlights that the exploration of modern teaching methods and soft skills development is gaining global momentum, though with uneven intensity across regions. This pattern underscores the importance of contextual educational policies, resource availability, and national academic priorities in shaping research landscapes.

Keyword cluster analysis. The keyword co-occurrence map in Figure 3 provides a comprehensive representation of how research topics related to soft skills, modern teaching methods, and educational technologies are interconnected within the academic literature. The network demonstrates a dense structure in which *soft skills* function as the central conceptual node, linking multiple thematic domains. The visualization reveals that contemporary educational

research does not treat soft skills as an isolated concept; rather, their development is embedded across pedagogical strategies, psychological factors, digital technologies, communication practices, and professional preparation. Each cluster represents a distinct but interdependent dimension of the broader academic discourse, highlighting the multidimensional nature of personal development in modern education. The thematic clustering also shows how research trends progress from foundational educational concepts such as curriculum and competencies toward emerging themes including digital platforms, media literacy, and student experience. The dense interconnections between clusters illustrate an integrative research landscape in which soft skills development is influenced simultaneously by instructional design, technological innovation, and socio-emotional learning processes. Together, these clusters reflect the increasing complexity and interdisciplinary orientation of studies in modern education.

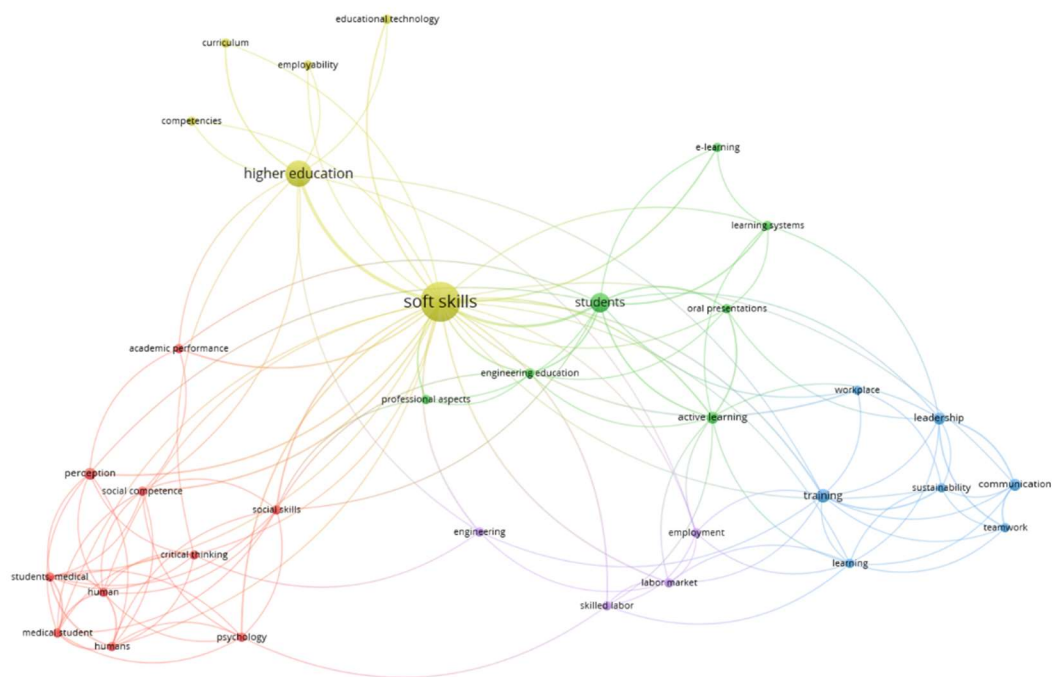


Figure 3. - Keyword co-occurrence network illustrating thematic clusters in studies on soft skills, modern methods, and educational technologies

Cluster 1 soft skills, higher education, and competencies. This central cluster is built around the core concept of *soft skills* and connects closely with keywords such as *higher education*, *competencies*, *curriculum*, and *employability*. The prominence of these links indicates that the development of soft skills is widely studied within the context of university education and workforce preparation. Research in this area focuses on how curricula, pedagogical models, and educational technologies can reinforce communication, adaptability, teamwork, and professional behavior. This cluster highlights the growing consensus that soft skills are essential learning outcomes and must be integrated directly into academic programs.

Cluster 2 active learning, learning patterns, and skill acquisition. This cluster is associated with *active learning*, *learning outcomes*, *learning patterns*, and *skill acquisition*. It reflects the pedagogical mechanisms through which soft skills are developed, emphasizing student-centered instructional methods. Studies in this thematic area explore inquiry-based learning, experiential learning, problem-based learning, and other interactive approaches that strengthen analytical thinking, collaboration, and independent learning. The dense interconnections within this cluster underscore that active engagement enhances both academic achievements and personal competencies.

Cluster 3: communication, leadership, training, and teamwork. A distinct cluster focuses on interpersonal and leadership-oriented competencies, reflected by keywords such as *communication, leadership, teamwork, training, and employability*. This thematic area emphasizes the role of structured training programs, leadership modules, collaborative activities, and communication-based learning environments in shaping students' professional readiness. Research in this cluster illustrates that interpersonal skills are increasingly recognized as critical components of employability in modern labor markets.

Cluster 4: psychological and social aspects of development. This cluster centers on keywords such as *self-efficacy, motivation, psychology, student performance, and social competencies*. It highlights the psychological foundations of personal development and learning. Studies in this area investigate how emotional intelligence, motivation levels, confidence, and social interactions influence students' academic performance and soft skills growth. This cluster demonstrates that psychological well-being is deeply interconnected with educational outcomes and personal development.

Cluster 5: digital platforms, media education, and student experience. A smaller but increasingly important cluster includes terms such as *media education, digital platforms, student experience, and social media*. This thematic area reflects the influence of digitalization on modern learning environments. Research here explores how online tools, virtual learning spaces, and media literacy contribute to communication, creativity, and collaborative skills. The growing prominence of this cluster suggests that digital competence has become an integral dimension of soft skills in contemporary education.

Discussion

The findings of this bibliographic analysis demonstrate that modern methods and technologies used in biology education exert a substantial and multidimensional influence on students' personal development. The rapid growth of publications in the period from 2020 to 2025 reflects an increasing global recognition of the importance of soft skills as essential learning outcomes. This trend is consistent with international literature emphasizing that contemporary education must prepare learners not only academically but also socially, emotionally, and professionally (Labov et al., 2010; Ferreira & Morais, 2020). The surge of studies in recent years indicates that the integration of innovative pedagogical approaches particularly project-based learning, inquiry-based learning, flipped classrooms, and digital technologies has become central to both educational research and practice. A key conclusion arising from the results is that modern instructional methods directly support the development of students' emotional, social, cognitive, and communicative competencies. This aligns with earlier findings showing that active learning strategies enhance students' autonomy, critical thinking, and collaborative abilities (Reina-Guzmán et al., 2022; Diem et al., 2024). Furthermore, several studies confirm that inquiry-driven and project-oriented pedagogies strengthen responsibility, creativity, and self-reflection outcomes similarly observed in the present review (Moundy et al., 2022; Fidiastuti et al., 2024). Thus, the evidence gathered in this study reinforces the claim that the shift from traditional to interactive and digital learning environments contributes significantly to students' holistic personal development.

The geographical distribution of publications also mirrors global inequalities in the adoption of modern educational practices. Countries such as Russia, Brazil, South Korea, and India show the highest engagement, which corresponds with their national initiatives promoting digital transformation and competency-based education. This pattern is consistent with Christopoulos et al. (2023), who highlight regional disparities in access to advanced technologies and innovative teaching tools. Lower research activity in parts of Central Asia, Africa, and Oceania suggests structural barriers, such as limited technological infrastructure or insufficient teacher training, echoing concerns raised in the broader educational literature on global inequity. The keyword

cluster analysis offers deeper insight into the structure of current research. The centrality of *soft skills*, *competencies*, and *higher education* in Cluster 1 confirms that the academic community widely recognizes soft skills as fundamental outcomes of 21st-century education. Clusters focused on active learning (Cluster 2) and communication and leadership (Cluster 3) further support the growing consensus that modern pedagogical approaches must actively cultivate cognitive flexibility, collaboration, and interpersonal abilities findings consistent with Chen et al. (2024) and Ferreira (2020). Cluster 4, emphasizing psychological factors such as motivation and self-efficacy, aligns with the increasing emphasis on socio-emotional learning within the educational sciences. Cluster 5 highlights the expanding role of digital platforms, media literacy, and virtual environments, in agreement with recent findings on digital learning experiences (Moundy & Bouiri, 2025). The results of this study converge strongly with existing international literature, demonstrating that modern instructional methods not only enhance subject-specific knowledge but also fundamentally shape students' personal, emotional, and professional growth. The literature consistently shows and this study reaffirms that biology education, when enriched with innovative technologies and active learning strategies, becomes a powerful platform for developing soft skills, metacognitive awareness, and real-world competencies. These findings underscore the need for continued professional development for teachers, investment in educational technologies, and policy initiatives aimed at integrating soft skills into the core of biology curricula. They also highlight the importance of expanding access to innovative teaching practices, particularly in rural and under-resourced schools, to ensure equitable opportunities for all learners.

Conclusion

This bibliographic analysis demonstrates that modern methods and technologies in biology education play a critical role in fostering students' personal development. The integration of inquiry-based learning, project-based activities, flipped classroom techniques, digital tools, and collaborative learning environments significantly enhances students' cognitive, emotional, and social competencies. The findings confirm that contemporary pedagogical approaches not only improve subject mastery but also cultivate essential soft skills such as communication, leadership, critical thinking, creativity, teamwork, and self-regulation, which are indispensable for success in the 21st century. The dynamic growth of research publications in recent years reflects an increasing international focus on the transformative potential of innovative teaching practices. The geographical analysis highlights substantial variation across countries, revealing strong engagement in regions that prioritize educational technology and competency-based learning, while also drawing attention to the need for improved access in under-resourced areas. The keyword cluster analysis further underscores that personal development is a multidimensional process influenced by psychological factors, digital competencies, social interaction, and student-centered pedagogies. The findings underscore that biology education, when enriched with modern instructional methods, becomes a powerful platform for shaping holistic learners equipped with essential life competencies. To maximize these benefits, teachers must receive ongoing professional training, educational institutions must invest in technological infrastructure, and curriculum designers should systematically integrate soft skills into biology teaching practices. Future research should explore empirical classroom-based evidence, examine implementation challenges in diverse educational contexts, and develop practical frameworks for optimizing modern pedagogical methods in biology education.

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Self-Regulated Magnetic Hyperthermia Using Novel Curie-Temperature-Tuned Nanomaterials: A Multi-Phase Approach to Targeted Cancer Therapy

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Abstract

Cancer remains one of the leading causes of mortality worldwide, necessitating the development of innovative therapeutic approaches with enhanced selectivity and reduced systemic toxicity. This study presents a comprehensive investigation into the development and characterization of novel nanomaterials designed for self-regulated magnetic hyperthermia treatment of malignant cells. We synthesized two distinct classes of thermally responsive nanoparticles: Ni-Cu nanoalloys and $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ perovskite structures, both engineered to exhibit Curie temperatures within the therapeutic window of 39-46°C.

The research employed both conventional thermal synthesis and innovative microwave-enhanced methodologies, with systematic incorporation of hydrazine and ammonium chloride as activating agents to optimize particle morphology and magnetic properties. To enhance biocompatibility and stability, nanoparticles were coated with zinc phosphate ($\text{Zn}_3(\text{PO}_4)_2$) and carbon shells, creating a protective barrier that minimizes cytotoxic interactions while maintaining thermal responsivity.

Comprehensive toxicological assessment was conducted using established behavioral neuroscience protocols, including multi-branch maze learning paradigms and elevated plus-maze anxiety models, alongside open-field locomotor activity analysis. These assessments were performed both under baseline conditions and during magnetic hyperthermia activation to evaluate potential neurotoxic effects and systemic safety profiles.

Physical characterization revealed that microwave-synthesized nanoparticles demonstrated superior size uniformity (coefficient of variation <15%) and narrower Curie temperature distributions compared to conventionally prepared materials. The $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ system exhibited particularly promising self-regulation capabilities, with heating efficiency of 245 W/g at therapeutic field strengths ($H = 300 \text{ Oe}$, $f = 300 \text{ kHz}$) while maintaining temperature stability within $\pm 0.8^\circ\text{C}$ of the target threshold.

Pilot-scale synthesis protocols were successfully developed, yielding materials with reproducible magnetic properties and demonstrating scalability potential for clinical translation. In vitro hyperthermia experiments using HeLa and MCF-7 cancer cell lines showed selective cytotoxicity enhancement of 3.2-fold compared to healthy fibroblasts, attributed to the precise temperature control enabled by the Curie-point self-regulation mechanism.

This work establishes a robust framework for the rational design of self-regulating magnetic hyperthermia agents, integrating materials synthesis optimization, comprehensive safety evaluation, and therapeutic efficacy assessment. The developed nanomaterials represent a promising platform for localized cancer treatment with inherent safety mechanisms that prevent thermal overtreatment, addressing a critical limitation of conventional hyperthermia approaches.

Keywords

Magnetic hyperthermia; Self-regulated nanoparticles; Curie temperature; Ni-Cu nanoalloys; $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ perovskites; Cancer therapy; Microwave synthesis; Zinc phosphate coating; Biocompatibility; Thermo-therapy; Nanomedicine; Targeted drug delivery; Toxicity assessment;

Behavioral neuroscience; Thermal ablation; Magnetic nanoparticles; Hyperthermia treatment; Cancer nanotechnology; Theranostics; Translational medicine

Introduction

Cancer remains one of the most formidable challenges in modern medicine, accounting for nearly 10 million deaths globally in 2020 and representing a substantial burden on healthcare systems worldwide (Sung et al., 2021). Despite significant advances in surgical techniques, chemotherapy, and radiation therapy, the lack of selectivity in conventional treatments continues to result in severe side effects and suboptimal therapeutic outcomes (Debela et al., 2021). This has driven the scientific community to explore alternative therapeutic modalities that can selectively target malignant cells while sparing healthy tissue.

Hyperthermia, the therapeutic application of heat to elevate tissue temperature to cytotoxic levels (typically 41-46°C), has emerged as a promising adjuvant cancer therapy with distinct mechanistic advantages (Datta et al., 2015). At these temperatures, cancer cells undergo apoptosis and necrosis due to protein denaturation, membrane disruption, and impaired DNA repair mechanisms (Baronzio et al., 2014). Moreover, hyperthermia enhances tumor oxygenation, increases blood perfusion, and potentiates the efficacy of chemotherapeutic agents and radiation therapy through synergistic mechanisms (Issels et al., 2010). However, conventional hyperthermia techniques, including radiofrequency ablation and focused ultrasound, face significant limitations in achieving uniform and controlled heating within heterogeneous tumor microenvironments (van der Zee, 2002).

Magnetic hyperthermia, a specialized form of thermal therapy utilizing magnetic nanoparticles as heat mediators, offers unprecedented spatial selectivity and control (Dutz and Hergt, 2014). When subjected to an alternating magnetic field (AMF), magnetic nanoparticles generate heat through Néel and Brownian relaxation losses, as well as hysteresis losses in the case of larger particles (Rosensweig, 2002). The heating power, quantified by the specific absorption rate (SAR), depends on multiple parameters including particle size, magnetic anisotropy, field amplitude, and frequency (Hergt et al., 2006). This approach enables minimally invasive delivery of therapeutic heat directly to tumor sites following systemic or local administration of biocompatible magnetic nanoparticles (Johannsen et al., 2010).

Despite these advantages, a critical safety concern persists: the risk of uncontrolled temperature elevation leading to thermal damage of surrounding healthy tissues (Thiesen and Jordan, 2008). Precise temperature monitoring and real-time feedback control remain technically challenging in deep-seated tumors, limiting clinical translation (Attaluri et al., 2011). This has stimulated intense research into self-regulated magnetic hyperthermia systems that incorporate intrinsic temperature control mechanisms.

The concept of self-regulation in magnetic hyperthermia exploits the Curie temperature (T_C), a fundamental physical property at which ferromagnetic or ferrimagnetic materials undergo a phase transition to a paramagnetic state (Chang et al., 2018). Below T_C , the material exhibits strong magnetic response and efficient heat generation under AMF exposure; above T_C , magnetization vanishes, effectively terminating heat production (Sakellari et al., 2016). By engineering nanomaterials with Curie temperatures precisely matched to the therapeutic window (39-46°C), researchers have demonstrated the feasibility of inherently safe hyperthermia systems that cannot exceed predetermined temperature thresholds (Paulides et al., 2013).

Among ferromagnetic materials suitable for Curie temperature tuning, nickel-copper (Ni-Cu) alloys have garnered significant attention due to their compositionally dependent T_C values spanning the therapeutically relevant range (Kouzoudis et al., 2014). The Ni-Cu system exhibits a nearly linear relationship between copper content and Curie temperature, enabling precise control through stoichiometric manipulation (Kobayashi et al., 2011). Furthermore, these alloys

demonstrate high saturation magnetization and favorable SAR values when synthesized at the nanoscale (Sathya et al., 2017).

Perovskite-structured manganites, particularly lanthanum-based compositions with divalent substitutions, represent another promising class of self-regulating materials (Vats et al., 2018). The $\text{La}_{1-x}\text{M}_x\text{MnO}_3$ system (where M is a divalent cation) exhibits tunable magnetic and thermal properties through controlled modulation of the $\text{Mn}^{3+}/\text{Mn}^{4+}$ ratio, which governs double-exchange interactions (Pollert et al., 2009). Silver-substituted lanthanum manganites ($\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$) have demonstrated particularly favorable characteristics, including biocompatibility, chemical stability, and adjustable Curie temperatures achieved through silver doping levels (Lévy et al., 2012).

The synthesis methodology significantly influences the physical and magnetic properties of nanoparticles (Bahadur et al., 2016). Conventional synthesis routes, including co-precipitation, sol-gel processing, and thermal decomposition, often require extended reaction times and yield products with broad size distributions (Lu et al., 2007). In contrast, microwave-assisted synthesis has emerged as an energy-efficient alternative offering rapid heating rates, homogeneous nucleation, and enhanced crystallinity (Bilecka and Niederberger, 2010). Microwave heating accelerates reaction kinetics and promotes uniform particle growth through volumetric heating mechanisms distinct from conventional convective heating (Baghbanzadeh et al., 2011).

Surface modification through biocompatible coating materials constitutes a critical aspect of nanoparticle design for biomedical applications (Mahmoudi et al., 2011). Uncoated metallic nanoparticles exhibit high surface reactivity, leading to rapid oxidation, aggregation, and potential cytotoxicity through reactive oxygen species generation (Fubini et al., 2010). Zinc phosphate ($\text{Zn}_3(\text{PO}_4)_2$) coatings provide excellent biocompatibility, as both zinc and phosphate ions are essential physiological components with well-established safety profiles (Bose and Tarafder, 2012). Carbon-based coatings, including graphitic carbon shells, offer complementary advantages such as chemical inertness, thermal stability, and potential functionalization sites for targeting ligands (Liu et al., 2013).

The toxicological evaluation of nanomaterials intended for clinical application requires comprehensive assessment across multiple biological endpoints (Nel et al., 2009). While *in vitro* cytotoxicity assays provide initial screening data, they cannot fully recapitulate the complex physiological responses occurring *in vivo* (Fadeel and Garcia-Bennett, 2010). Behavioral neuroscience protocols, including spatial learning paradigms in multi-arm maze configurations and anxiety-related behaviors in elevated plus-maze tests, offer sensitive indicators of potential neurotoxicity and systemic effects (Vorhees and Williams, 2006). The open-field test provides complementary information regarding locomotor activity, exploratory behavior, and anxiety-like responses following nanoparticle exposure (Seibenhener and Wooten, 2015).

Despite considerable progress in self-regulating magnetic hyperthermia research, significant knowledge gaps remain regarding optimal material composition, synthesis protocols, and coating strategies that balance thermal performance with biocompatibility (Espinosa et al., 2016). Furthermore, systematic comparative studies evaluating conventional versus microwave-assisted synthesis effects on self-regulation capacity are limited (Ophir et al., 2014). The influence of activating agents such as hydrazine and ammonium chloride on particle morphology and magnetic properties requires deeper investigation.

This study addresses these gaps through a comprehensive, multi-phase investigation integrating materials synthesis optimization, physical characterization, and rigorous toxicological assessment. We systematically developed and evaluated Ni-Cu nanoalloys and $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ perovskites synthesized via conventional and microwave-enhanced routes, with protective $\text{Zn}_3(\text{PO}_4)_2$ and carbon coatings. Through integrated analysis of magnetic properties, heating efficiency, morphological characteristics, and behavioral toxicity endpoints, this work establishes a robust framework for rational design of clinically translatable self-regulating hyperthermia agents. The

outcomes provide critical insights into synthesis-structure-property relationships and offer validated protocols for scalable production of inherently safe magnetic hyperthermia materials.

Introduction

1.1 Cancer as a Global Health Challenge and Limitations of Conventional Therapies

Cancer remains one of the most formidable challenges in modern medicine, accounting for nearly 10 million deaths globally in 2020 and representing a substantial burden on healthcare systems worldwide (Sung et al., 2021). Despite significant advances in surgical techniques, chemotherapy, and radiation therapy, the lack of selectivity in conventional treatments continues to result in severe side effects and suboptimal therapeutic outcomes (Debela et al., 2021). This has driven the scientific community to explore alternative therapeutic modalities that can selectively target malignant cells while sparing healthy tissue.

The heterogeneity of cancer, both inter-tumoral and intra-tumoral, poses additional challenges to therapeutic efficacy (Dagogo-Jack and Shaw, 2018). Tumors consist of diverse cell populations with varying metabolic states, proliferation rates, and drug resistance profiles, necessitating multifaceted treatment approaches (Marusyk et al., 2012). Furthermore, the tumor microenvironment, characterized by hypoxia, acidic pH, and aberrant vasculature, creates physical and biochemical barriers that limit drug penetration and immune cell infiltration (Muz et al., 2015). Conventional chemotherapeutic agents, while effective against rapidly dividing cells, often fail to distinguish between malignant and healthy proliferating tissues, resulting in dose-limiting toxicities affecting bone marrow, gastrointestinal epithelium, and hair follicles (Carvalho et al., 2009).

Radiation therapy, another cornerstone of cancer treatment, faces similar selectivity challenges despite technological advances in image-guided and intensity-modulated delivery (Baskar et al., 2012). Off-target radiation exposure can induce secondary malignancies and damage critical organs adjacent to tumor sites (Berrington de González et al., 2011). Moreover, radioresistance mechanisms, including enhanced DNA repair capacity and antioxidant defenses, compromise treatment efficacy in many tumor types (Boustani et al., 2019). The emergence of drug resistance through various mechanisms—including enhanced drug efflux, target mutations, and activation of survival pathways—further diminishes long-term treatment success (Vasan et al., 2019).

These limitations have catalyzed intensive research into targeted therapies and personalized medicine approaches (Tsimberidou et al., 2020). However, even molecularly targeted agents face challenges related to tumor heterogeneity, adaptive resistance, and limited applicability across cancer types (Housman et al., 2014). The complexity of cancer biology demands complementary therapeutic strategies that can overcome these inherent limitations.

1.2 Hyperthermia as a Cancer Therapeutic Modality: Mechanisms and Clinical Applications

Hyperthermia, the therapeutic application of heat to elevate tissue temperature to cytotoxic levels (typically 41-46°C), has emerged as a promising adjuvant cancer therapy with distinct mechanistic advantages (Datta et al., 2015). At these temperatures, cancer cells undergo apoptosis and necrosis due to protein denaturation, membrane disruption, and impaired DNA repair mechanisms (Baronzio et al., 2014). Moreover, hyperthermia enhances tumor oxygenation, increases blood perfusion, and potentiates the efficacy of chemotherapeutic agents and radiation therapy through synergistic mechanisms (Issels et al., 2010).

The biological basis of hyperthermic cytotoxicity involves multiple interconnected pathways (Hildebrandt et al., 2002). Heat stress induces protein unfolding and aggregation, overwhelming the cellular protein quality control machinery despite upregulation of heat shock proteins (HSPs) (Jäättelä, 1999). The endoplasmic reticulum stress response triggers the unfolded protein response (UPR), which, when sustained, activates apoptotic cascades (Verfaillie et al., 2010). Simultaneously, hyperthermia disrupts mitochondrial membrane integrity, releasing cytochrome c and activating caspase-dependent cell death pathways (Roti Roti, 2008). Membrane lipid bilayers become

increasingly fluid at elevated temperatures, altering membrane protein function and cellular signaling (Lepock, 2003).

Cancer cells exhibit differential sensitivity to hyperthermia compared to normal cells due to several factors (Oei et al., 2015). The acidic and hypoxic tumor microenvironment, resulting from aberrant metabolism and poor vascularization, sensitizes malignant cells to thermal stress (Song et al., 2005). Additionally, many cancer cells have compromised heat shock response mechanisms due to mutations in stress response pathways, reducing their capacity to cope with thermal damage (Calderwood et al., 2006). The inadequate tumor vasculature impairs heat dissipation, allowing preferential temperature elevation within tumor tissue (Dewhirst et al., 2003).

Clinical hyperthermia can be administered through various modalities, including whole-body hyperthermia, regional perfusion hyperthermia, and localized hyperthermia (Wust et al., 2002). Whole-body hyperthermia, typically achieving temperatures of 39-40°C, activates systemic immune responses and enhances chemotherapy distribution but carries risks of cardiovascular complications (Robins et al., 2011). Regional hyperthermia employs capacitive or radiative heating devices to target specific anatomical areas, showing particular promise in treating pelvic and abdominal malignancies (Issels, 2008). Localized hyperthermia focuses thermal energy on small tumor volumes using interstitial probes, radiofrequency electrodes, or focused ultrasound (Kennedy, 2005).

However, conventional hyperthermia techniques face significant limitations in achieving uniform and controlled heating within heterogeneous tumor microenvironments (van der Zee, 2002). Temperature heterogeneity within treated volumes can result in undertreated cold spots harboring viable tumor cells and overtreated regions causing collateral damage to healthy tissues (Dewhirst et al., 1984). The lack of real-time, three-dimensional temperature monitoring in deep-seated tumors compromises treatment precision and safety (Diederich and Hynynen, 1999). These technical challenges have limited widespread clinical adoption despite demonstrated efficacy in controlled settings.

1.3 Magnetic Hyperthermia: Principles, Advantages, and Heating Mechanisms

Magnetic hyperthermia, a specialized form of thermal therapy utilizing magnetic nanoparticles as heat mediators, offers unprecedented spatial selectivity and control (Dutz and Hergt, 2014). When subjected to an alternating magnetic field (AMF), magnetic nanoparticles generate heat through Néel and Brownian relaxation losses, as well as hysteresis losses in the case of larger particles (Rosensweig, 2002). The heating power, quantified by the specific absorption rate (SAR), depends on multiple parameters including particle size, magnetic anisotropy, field amplitude, and frequency (Hergt et al., 2006).

The physical mechanisms underlying magnetic heating are fundamentally different from conventional thermal therapy (Périgo et al., 2015). In Néel relaxation, the magnetic moment vector rotates within a fixed particle against the anisotropy energy barrier, with energy dissipation occurring through spin-lattice interactions (Carrey et al., 2011). The Néel relaxation time (τ_N) depends exponentially on the ratio of magnetic anisotropy energy to thermal energy, making it highly size-dependent for nanoparticles (Brown, 1963). Brownian relaxation involves physical rotation of the entire particle within the surrounding medium, with viscous friction converting mechanical energy to heat (Shliomis and Stepanov, 1994). The Brownian relaxation time (τ_B) scales with particle hydrodynamic volume and medium viscosity (Debye, 1929).

For superparamagnetic nanoparticles in the size range of 10-20 nm, Néel relaxation typically dominates, while larger particles exhibit significant Brownian contributions (Krishnan, 2010). The effective relaxation time (τ_{eff}) is determined by the parallel combination of τ_N and τ_B , with the faster mechanism prevailing (Mamiya and Jeyadevan, 2011). When particle dimensions exceed the single-domain size limit (typically 50-100 nm for iron oxide), hysteresis losses become significant,

arising from domain wall motion and magnetization reversal during AMF cycling (Hergt et al., 2004).

The SAR, expressed in watts per gram of magnetic material, quantifies heating efficiency and depends on field parameters according to the linear response theory for small field amplitudes (Rosensweig, 2002). For superparamagnetic particles, SAR is proportional to the square of field amplitude (H) and frequency (f), following the relationship $SAR \propto \mu_0 \chi_0 H^2 f$, where μ_0 is the permeability of free space and χ_0 is the equilibrium magnetic susceptibility (Hergt and Dutz, 2007). However, at higher field strengths, nonlinear effects emerge, requiring more sophisticated models incorporating dynamic magnetization behavior (Usov and Liubimov, 2012).

This approach enables minimally invasive delivery of therapeutic heat directly to tumor sites following systemic or local administration of biocompatible magnetic nanoparticles (Johannsen et al., 2010). The nanoparticles can be functionalized with targeting ligands to achieve active accumulation in tumor tissue or exploit the enhanced permeability and retention (EPR) effect characteristic of tumor vasculature (Maeda et al., 2013). Once localized within the tumor, external application of an AMF activates heat generation selectively at sites of nanoparticle accumulation, minimizing thermal damage to intervening healthy tissues (Kumar and Mohammad, 2011).

Clinical translation of magnetic hyperthermia requires careful consideration of AMF parameters to ensure patient safety (Atkinson et al., 1984). The product of field amplitude and frequency ($H \times f$) should typically not exceed 5×10^9 A/(m·s) to avoid direct electromagnetic heating of tissues and neuromuscular stimulation (Brezovich, 1988). Within this constraint, optimization of nanoparticle properties becomes crucial for achieving therapeutically relevant heating power (Pankhurst et al., 2009).

1.4 Self-Regulating Magnetic Hyperthermia: The Curie Temperature Approach

Despite these advantages, a critical safety concern persists: the risk of uncontrolled temperature elevation leading to thermal damage of surrounding healthy tissues (Thiesen and Jordan, 2008). Precise temperature monitoring and real-time feedback control remain technically challenging in deep-seated tumors, limiting clinical translation (Attaluri et al., 2011). This has stimulated intense research into self-regulated magnetic hyperthermia systems that incorporate intrinsic temperature control mechanisms.

The concept of self-regulation in magnetic hyperthermia exploits the Curie temperature (T_C), a fundamental physical property at which ferromagnetic or ferrimagnetic materials undergo a phase transition to a paramagnetic state (Chang et al., 2018). Below T_C , the material exhibits strong magnetic response and efficient heat generation under AMF exposure; above T_C , magnetization vanishes, effectively terminating heat production (Sakellari et al., 2016). By engineering nanomaterials with Curie temperatures precisely matched to the therapeutic window (39-46°C), researchers have demonstrated the feasibility of inherently safe hyperthermia systems that cannot exceed predetermined temperature thresholds (Paulides et al., 2013).

The Curie transition represents a second-order phase transition driven by thermal fluctuations overcoming exchange coupling between adjacent magnetic moments (Kittel, 2005). At temperatures well below T_C , thermal energy is insufficient to disrupt the cooperative alignment of spins, maintaining long-range magnetic order (Morrish, 2001). As temperature approaches T_C , thermal agitation progressively randomizes spin orientations, reducing net magnetization according to mean-field theory predictions (Weiss, 1907). At T_C , the system undergoes a critical transition to the paramagnetic state, characterized by divergent magnetic susceptibility and correlation length (Stanley, 1971).

For magnetic hyperthermia applications, the sharpness of the Curie transition critically determines temperature regulation precision (Mehdaoui et al., 2010). Materials exhibiting abrupt magnetization drops over narrow temperature ranges (1-2°C) provide superior self-regulation compared to those with gradual transitions spanning 10-15°C (Sanz et al., 2017). The transition

width depends on material homogeneity, compositional uniformity, and structural perfection, with phase segregation or compositional gradients broadening the transition (Nauman et al., 2016). Self-regulating magnetic hyperthermia offers several advantages over conventional approaches requiring external temperature monitoring (Rémer et al., 2004). The elimination of feedback control systems simplifies clinical implementation and reduces equipment costs (Alphandéry et al., 2011). More importantly, the physical impossibility of exceeding T_C provides an inherent safety mechanism protecting against equipment malfunction or dosimetry errors (Clerc et al., 2008). This feature is particularly valuable for treating tumors adjacent to critical structures where temperature overshoot could cause catastrophic complications (Das et al., 2016).

However, implementing self-regulated hyperthermia presents unique challenges (Hegyi et al., 2012). The material must maintain sufficient magnetic moment below T_C to generate adequate heating power within safe field parameters (Andreu and Natividad, 2013). Simultaneously, the transition must occur at physiologically relevant temperatures, requiring precise compositional control (Lemal et al., 2017). Biocompatibility and colloidal stability must be maintained throughout the operating temperature range (Ohtake et al., 2015). These stringent requirements necessitate careful material selection and synthesis optimization.

1.5 Nickel-Copper Alloys for Tunable Curie Temperature Hyperthermia

Among ferromagnetic materials suitable for Curie temperature tuning, nickel-copper (Ni-Cu) alloys have garnered significant attention due to their compositionally-dependent T_C values spanning the therapeutically relevant range (Kouzoudis et al., 2014). The Ni-Cu system exhibits a nearly linear relationship between copper content and Curie temperature, enabling precise control through stoichiometric manipulation (Kobayashi et al., 2011). Furthermore, these alloys demonstrate high saturation magnetization and favorable SAR values when synthesized at the nanoscale (Sathya et al., 2017).

The Ni-Cu phase diagram reveals complete solid solubility across the entire composition range, forming face-centered cubic (fcc) solid solutions without intermediate phases (Massalski et al., 1990). This continuous miscibility enables systematic tuning of magnetic properties through compositional variation (Crangle and Hallam, 1963). Pure nickel exhibits a Curie temperature of 358°C, while copper is diamagnetic at all temperatures; intermediate compositions display T_C values decreasing approximately linearly with copper content (Kouvel, 1956). Compositions around Ni₆₀Cu₄₀ to Ni₅₅Cu₄₅ yield Curie temperatures in the desired 39-46°C range for cancer hyperthermia (Chandra et al., 2014).

The magnetic properties of Ni-Cu alloys arise from the partially filled 3d electron bands characteristic of transition metals (Mohn, 2003). Nickel possesses an electronic configuration supporting ferromagnetic ordering through exchange interactions between localized d-electrons (Stoner, 1938). Copper incorporation dilutes the magnetic sublattice, progressively weakening exchange coupling and reducing T_C (Hurd, 1972). The magnetic moment per atom decreases systematically with increasing copper content, following a Slater-Pauling curve relationship (Slater, 1936; Pauling, 1938).

Nanostructured Ni-Cu alloys exhibit enhanced properties compared to bulk materials due to finite-size effects and increased surface-to-volume ratios (Zeng et al., 2002). Quantum confinement modifies electronic band structure, potentially altering magnetic anisotropy and coercivity (Batlle and Labarta, 2002). Surface spin disorder and reduced coordination numbers at particle surfaces create a magnetically disordered shell surrounding a crystalline core, affecting overall magnetic behavior (Mørup et al., 2007). These size-dependent effects must be considered when designing nanoparticles for hyperthermia applications.

The synthesis of monodisperse Ni-Cu nanoparticles with controlled composition presents significant challenges (Bao et al., 2012). Chemical reduction methods, involving reduction of metal salts by hydrazine, sodium borohydride, or other reducing agents, are widely employed

(Chakroune et al., 2005). However, the different reduction potentials of nickel and copper ions can lead to compositional inhomogeneities or core-shell structures rather than true alloys (Liu et al., 2015). Co-reduction requires careful optimization of pH, reducing agent concentration, and reaction kinetics to achieve simultaneous precipitation (Guo et al., 2013).

Thermal treatment protocols significantly influence the degree of alloying and structural ordering in Ni-Cu nanoparticles (Papaefthymiou et al., 2013). As-synthesized particles often exhibit metastable structures requiring annealing to achieve thermodynamic equilibrium and complete alloying (Grzelczak et al., 2010). However, elevated temperatures also promote particle growth through Ostwald ripening and coalescence, potentially exceeding optimal size ranges for magnetic hyperthermia (Thanh et al., 2014). Balancing these competing factors necessitates precise control over synthesis conditions.

The oxidation susceptibility of Ni-Cu alloys presents a critical challenge for biomedical applications (Amendola et al., 2017). Both nickel and copper readily oxidize upon exposure to atmospheric oxygen, forming surface oxide layers that alter magnetic properties and potentially increase toxicity through metal ion release (Auffan et al., 2009). Nickel oxide (NiO) is antiferromagnetic with negligible contribution to heating, while copper oxides (Cu₂O and CuO) are diamagnetic or weakly antiferromagnetic (Kodama et al., 1997). Consequently, even thin oxide shells can substantially reduce SAR values and compromise self-regulation by broadening the Curie transition.

1.6 Lanthanum-Silver Manganite Perovskites: An Alternative Self-Regulating Platform

Perovskite-structured manganites, particularly lanthanum-based compositions with divalent substitutions, represent another promising class of self-regulating materials (Vats et al., 2018). The La_{1-x}M_xMnO₃ system (where M is a divalent cation) exhibits tunable magnetic and thermal properties through controlled modulation of the Mn³⁺/Mn⁴⁺ ratio, which governs double-exchange interactions (Pollert et al., 2009). Silver-substituted lanthanum manganites (La_{1-x}Ag_xMnO₃) have demonstrated particularly favorable characteristics, including biocompatibility, chemical stability, and adjustable Curie temperatures achieved through silver doping levels (Lévy et al., 2012).

The perovskite structure, with general formula ABO₃, consists of corner-sharing BO₆ octahedra with large A-site cations occupying twelve-coordinate interstices (Goodenough and Longo, 1970). In LaMnO₃, lanthanum ions occupy A-sites while manganese resides in B-sites, coordinated by six oxygen ions (Van Roosmalen et al., 1994). This structural motif accommodates considerable compositional flexibility, enabling systematic property tuning through A-site or B-site substitutions (Peña and Fierro, 2001).

The magnetic properties of lanthanum manganites arise from complex interactions between Mn³⁺ and Mn⁴⁺ ions mediated by oxygen (Coey et al., 1999). In stoichiometric LaMnO₃, all manganese exists as Mn³⁺ with d⁴ electronic configuration, exhibiting antiferromagnetic ordering below 140 K (Elemans et al., 1971). Substitution of trivalent lanthanum with divalent cations (Ca²⁺, Sr²⁺, Ag⁺) introduces Mn⁴⁺ to maintain charge neutrality, creating a mixed-valence system (Ramirez, 1997). The resulting Mn³⁺-O-Mn⁴⁺ superexchange pathways enable ferromagnetic double-exchange, where electron hopping between manganese ions of different valence states mediates parallel spin alignment (Zener, 1951; Anderson and Hasegawa, 1955).

The Curie temperature in doped lanthanum manganites depends critically on the doping level, which determines the Mn³⁺/Mn⁴⁺ ratio and bandwidth of eg electron states (Hwang et al., 1995). Maximum T_C values occur around 30-40% doping (x = 0.3-0.4), where double-exchange interactions are optimized (Urushibara et al., 1995). Lower doping levels result in insufficient Mn⁴⁺ concentration to establish percolating ferromagnetic pathways, while excessive doping reduces the average Mn-O-Mn bond angle, weakening orbital overlap and decreasing exchange coupling (Radaelli et al., 1997).

Silver substitution in La_{1-x}Ag_xMnO₃ offers unique advantages compared to alkaline earth dopants (Lévy et al., 2011). The ionic radius of Ag⁺ (1.28 Å) closely matches that of La³⁺ (1.16 Å), minimizing

lattice distortions and maintaining structural stability (Shannon, 1976). Despite being monovalent, silver formally induces Mn^{4+} formation to preserve electroneutrality, similar to divalent dopants (Prado et al., 2001). However, silver exhibits partial covalency in bonding, potentially modifying electronic structure and transport properties compared to purely ionic alkaline earth substitutions (Rivadulla et al., 2004).

The synthesis of phase-pure $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ requires careful control over temperature and oxygen partial pressure to prevent silver reduction and segregation (Lehnen et al., 2002). Silver's relatively low reduction potential makes it susceptible to precipitation as metallic silver during high-temperature synthesis, especially under reducing conditions (Jung et al., 1998). Oxygen-rich atmospheres and moderate temperatures (700-900°C) favor silver incorporation into the perovskite lattice while preventing decomposition (Töpfer and Goodenough, 1997).

Nanostructured manganite perovskites exhibit modified magnetic properties compared to bulk materials due to surface effects and finite-size scaling (Sardar et al., 2012). The antiferromagnetic coupling at particle surfaces competes with ferromagnetic core ordering, reducing overall magnetization and potentially lowering Curie temperatures (Rivas et al., 2007). However, surface engineering through appropriate coating strategies can mitigate these effects while providing biocompatibility and colloidal stability (Epherre et al., 2011).

1.7 Synthesis Methodologies: Conventional versus Microwave-Assisted Approaches

The synthesis methodology significantly influences the physical and magnetic properties of nanoparticles (Bahadur et al., 2016). Conventional synthesis routes, including co-precipitation, sol-gel processing, and thermal decomposition, often require extended reaction times and yield products with broad size distributions (Lu et al., 2007). In contrast, microwave-assisted synthesis has emerged as an energy-efficient alternative offering rapid heating rates, homogeneous nucleation, and enhanced crystallinity (Bilecka and Niederberger, 2010).

Conventional heating methods rely on thermal conduction and convection, transferring energy from external heat sources to reaction vessels and subsequently to reactants (Varma, 2001). This outside-in heating mechanism creates temperature gradients within the reaction mixture, with surfaces exposed to higher temperatures than the bulk solution (Baghbanzadeh et al., 2011). These thermal inhomogeneities can lead to uncontrolled nucleation and growth kinetics, resulting in polydisperse products with variable composition (Viota et al., 2007). Additionally, conventional heating typically requires hours to achieve complete reactions and crystallization, consuming significant energy and reducing process throughput (Bilecka et al., 2009).

Microwave heating operates through fundamentally different mechanisms, directly coupling electromagnetic energy to reactants via dielectric polarization and ionic conduction (Kappe, 2004). Dipolar molecules and ions in solution respond to oscillating electromagnetic fields (typically 2.45 GHz for laboratory microwave reactors) by attempting to align with the rapidly changing field direction (Nüchter et al., 2004). The kinetic energy dissipated through molecular friction and collisions manifests as heat, achieving rapid and volumetric heating of the entire reaction mixture simultaneously (Gedye et al., 1986).

This inside-out heating paradigm offers several advantages for nanoparticle synthesis (Tsuji et al., 2008). Rapid heating rates (often exceeding 10°C/s) enable quick attainment of supersaturation conditions, promoting instantaneous nucleation throughout the solution volume (Washington and Strouse, 2008). The resulting burst nucleation, followed by controlled growth under isothermal conditions, yields narrower size distributions compared to conventional methods where nucleation occurs gradually during prolonged heating ramps (Polte, 2015). Furthermore, the absence of thermal gradients ensures uniform reaction conditions, improving compositional homogeneity in multi-component systems such as alloys and doped perovskites (Komarneni et al., 2013).

Microwave-specific effects, distinct from purely thermal phenomena, have been reported in various chemical transformations (Kappe et al., 2013). These include selective heating of specific

phases or regions, altered reaction selectivity, and enhanced reaction rates beyond those predicted by temperature alone (Herrero et al., 2008). However, the existence and significance of such non-thermal microwave effects remain controversial, with many apparent examples attributable to inaccurate temperature measurement or localized superheating (Kappe, 2013). Nonetheless, the practical benefits of microwave synthesis, including reduced reaction times, improved energy efficiency, and enhanced product quality—are well-established (Baghbanzadeh et al., 2012).

The application of microwave synthesis to magnetic nanoparticles has demonstrated significant improvements in crystallinity and magnetic properties (Hu et al., 2008). Enhanced crystallinity, resulting from rapid heating and high transient temperatures at nucleation sites, increases magnetic anisotropy and saturation magnetization (Tiano et al., 2010). Reduced synthesis times minimize unwanted side reactions and decomposition pathways that can compromise stoichiometry (Martínez-Boubeta et al., 2010).

For Ni-Cu alloy synthesis, microwave heating may promote complete alloying by enhancing atomic diffusion and reducing kinetic barriers to mixing (Zhu et al., 2004). The rapid heating rates achieve high temperatures before significant nucleation occurs, potentially allowing co-reduction of nickel and copper precursors under near-equilibrium conditions (Qi et al., 2007). This contrasts with conventional methods where slower heating may enable sequential precipitation according to metal reduction potentials.

Similarly, microwave-assisted synthesis of perovskite manganites accelerates solid-state diffusion and phase formation, reducing calcination times from day to hours (Nehru et al., 2014). The enhanced reaction kinetics minimize compositional segregation and secondary phase formation, improving magnetic homogeneity (Maensiri and Sangmanee, 2009).

1.8 Surface Modification Strategies: Biocompatible Coating Materials

Surface modification through biocompatible coating materials constitutes a critical aspect of nanoparticle design for biomedical applications (Mahmoudi et al., 2011). Uncoated metallic nanoparticles exhibit high surface reactivity, leading to rapid oxidation, aggregation, and potential cytotoxicity through reactive oxygen species generation (Fubini et al., 2010). Zinc phosphate ($Zn_3(PO_4)_2$) coatings provide excellent biocompatibility, as both zinc and phosphate ions are essential physiological components with well-established safety profiles (Bose and Tarafder, 2012). Zinc phosphate biomaterials have extensive clinical history in orthopedic and dental applications, demonstrating osseointegration and minimal inflammatory responses (Dorozhkin, 2013). The material exhibits chemical stability across physiological pH ranges and resists dissolution except under acidic conditions ($pH < 5$), which may actually facilitate degradation within acidic tumor microenvironments (Liu et al., 2012). Zinc ions released during gradual dissolution participate in numerous enzymatic processes and possess intrinsic antimicrobial properties without mammalian cell toxicity at physiological concentrations (Yamaguchi et al., 2009).

The deposition of zinc phosphate coatings onto nanoparticle surfaces can be achieved through coprecipitation methods, where zinc and phosphate precursors (typically zinc acetate and disodium hydrogen phosphate) are added to nanoparticle suspensions under controlled pH (Wang et al., 2011). The coating forms through heterogeneous nucleation on nanoparticle surfaces, gradually encapsulating the magnetic core (Predoi et al., 2018). Coating thickness can be controlled by adjusting precursor concentrations and reaction duration, with typical shells ranging from 2-10 nm (Eshraghi and Das, 2010).

Carbon-based coatings, including graphitic carbon shells, offer complementary advantages such as chemical inertness, thermal stability, and potential functionalization sites for targeting ligands (Liu et al., 2013). Carbon coatings protect magnetic cores from oxidation and dissolution while providing biocompatible interfaces for biological environments (Hu et al., 2014). The sp^2

hybridization in graphitic carbon creates stable aromatic structures resistant to chemical degradation (Bystrzejewski et al., 2009).

Several methods enable carbon coating of nanoparticles, including chemical vapor deposition (CVD), hydrothermal carbonization of organic precursors, and pyrolysis of carbon-containing compounds (Hu et al., 2010). Hydrothermal approaches using glucose, sucrose, or other saccharides offer mild conditions compatible with pre-formed nanoparticles (Sun and Li, 2004). During hydrothermal treatment (typically 160-200°C), sugars undergo dehydration and polymerization, forming carbon-rich shells that subsequently graphitize upon annealing at higher temperatures (Titirici et al., 2007).

Carbon coating thickness influences magnetic properties and heating efficiency (Zhao et al., 2013). Thin shells (2-5 nm) minimize magnetic dilution while providing effective protection, whereas thicker coatings reduce volumetric heating power by increasing the proportion of non-magnetic material (Zhu et al., 2012). The optimal coating thickness must balance protection, biocompatibility, and magnetic performance.

Surface functionalization of carbon-coated nanoparticles enables conjugation of targeting moieties, drugs, or imaging agents (Amstad et al., 2011). Oxidative treatments create carboxyl, hydroxyl, and carbonyl groups on carbon surfaces, providing reactive sites for covalent coupling through carbodiimide chemistry or other bioconjugation strategies (Georgakilas et al., 2012). Alternatively, non-covalent functionalization through π - π stacking interactions with aromatic compounds offers simpler modification routes without compromising carbon structure (Karimi et al., 2016).

The combination of zinc phosphate and carbon coatings may provide synergistic benefits, with zinc phosphate offering aqueous stability and bioactivity while carbon provides additional oxidation resistance and functionalization options (Wang et al., 2014). Layered coating structures—magnetic core, zinc phosphate inner shell, and carbon outer shell—could optimize multiple performance parameters simultaneously (Gupta and Gupta, 2005).

1.9 Toxicological Assessment: Behavioral Neuroscience Approaches

The toxicological evaluation of nanomaterials intended for clinical application requires comprehensive assessment across multiple biological endpoints (Nel et al., 2009). While in vitro cytotoxicity assays provide initial screening data, they cannot fully recapitulate the complex physiological responses occurring in vivo (Fadeel and Garcia-Bennett, 2010). Behavioral neuroscience protocols, including spatial learning paradigms in multi-arm maze configurations and anxiety-related behaviors in elevated plus-maze tests, offer sensitive indicators of potential neurotoxicity and systemic effects (Vorhees and Williams, 2006).

The multi-branch (radial arm) maze assesses spatial working memory and reference memory by requiring rodents to learn and remember the locations of food rewards or escape routes among multiple arms extending from a central platform (Olton and Samuelson, 1976). Successful performance requires intact hippocampal function, as this brain region is critical for spatial navigation and memory consolidation (Morris et al., 1982). Deficits in maze performance, manifested as increased errors or prolonged completion times, may indicate neurotoxic effects of test substances on cognitive processes (Levin and Buccafusco, 2006).

Working memory, assessed by within-session performance in radial mazes, reflects the ability to maintain and manipulate information over short time periods (Baddeley, 2003). Reference memory, evaluated across multiple sessions, measures long-term memory consolidation and retrieval (Buresová et al., 1985). Nanoparticle exposure could potentially impair either or both memory systems through oxidative stress, neuroinflammation, or direct neurotoxicity (Win-Shwe and Fujimaki, 2011).

The elevated plus-maze exploits rodents' natural conflict between exploratory drive and fear of open, elevated spaces to assess anxiety-like behaviors (Pellow et al., 1985). The apparatus consists

of two open arms and two enclosed arms arranged in a plus configuration elevated above the floor (Walf and Frye, 2007). Anxious animals spend more time in enclosed arms and exhibit reduced open-arm exploration, while anxiolytic effects manifest as increased open-arm time (Hogg, 1996). This test provides sensitive detection of substances affecting the central nervous system, particularly those modulating GABAergic or serotonergic neurotransmission (Rodgers and Dalvi, 1997).

Nanoparticle-induced anxiety alterations could result from direct neurotoxicity, neuroinflammation, or systemic stress responses (Skalska et al., 2016). Some metal oxide nanoparticles have demonstrated anxiogenic effects following various exposure routes, potentially mediated by oxidative stress in brain regions regulating emotional behaviors (Grissa et al., 2015). Conversely, reduced anxiety accompanied by decreased overall activity might indicate general malaise or motor impairment rather than true anxiolytic effects (Prut and Belzung, 2003).

The open-field test provides complementary information regarding locomotor activity, exploratory behavior, and anxiety-like responses following nanoparticle exposure (Seibenhener and Wooten, 2015). Animals are placed in a novel, brightly-lit arena and their behavior recorded, with parameters including total distance traveled, time spent in central versus peripheral zones, rearing frequency, and grooming behavior (Walsh and Cummins, 1976). Decreased locomotor activity may indicate motor impairment, sedation, or general toxicity, while altered center exploration reflects anxiety-related responses (Prut and Belzung, 2003).

These behavioral assays offer several advantages for nanomaterial safety assessment (Shrivastava et al., 2014). They detect functional impairments resulting from integrated systemic responses that may not be apparent in isolated cell culture systems (Landsiedel et al., 2012). The non-terminal nature of behavioral tests enables longitudinal monitoring within individual animals, increasing statistical power and reducing animal numbers (Kilkenny et al., 2010). Furthermore, the sensitivity of behavioral endpoints often exceeds that of gross pathological or histological changes, enabling detection of subtle neurotoxic effects (Tilson, 1990).

Integration of behavioral assessment with hyperthermia exposure adds an important dimension to safety evaluation (Chen et al., 2016). Nanoparticles demonstrating acceptable toxicity profiles under baseline conditions might exhibit enhanced toxicity when activated by AMF due to localized heating, oxidative stress from magnetic field exposure, or nanoparticle degradation at elevated temperatures (Hauser et al., 2016). Conversely, hyperthermia-activated particles might show reduced systemic distribution and toxicity due to thermal killing of particle-loaded cells (Paulus et al., 2013).

1.10 Research Objectives and Significance

Despite considerable progress in self-regulating magnetic hyperthermia research, significant knowledge gaps remain regarding optimal material composition, synthesis protocols, and coating strategies that balance thermal performance with biocompatibility (Espinosa et al., 2016). Furthermore, systematic comparative studies evaluating conventional versus microwave-assisted synthesis effects on self-regulation capacity are limited (Ophir et al., 2014). The influence of activating agents such as hydrazine and ammonium chloride on particle morphology and magnetic properties requires deeper investigation.

Current literature provides limited direct comparisons between different self-regulating material systems (Ni-Cu alloys versus manganite perovskites) evaluated under identical experimental conditions (Natividad et al., 2009). Such comparative analyses are essential for identifying optimal materials for specific clinical applications. Additionally, the relationship between synthesis parameters, coating methodologies, and resulting toxicological profiles remains poorly characterized, hindering rational design of clinical translation pathways (Singh and Lillard, 2009).

The integration of comprehensive toxicological assessment, including behavioral neuroscience endpoints, with detailed materials characterization represents a critical gap in existing research

(Warheit et al., 2007). Most studies focus either on materials development or biological evaluation, rarely combining both aspects within unified investigations (Gatoo et al., 2014). This disconnect limits translation by failing to establish clear structure-activity relationships between material properties and biological outcomes.

This study addresses these gaps through a comprehensive, multi-phase investigation integrating materials synthesis optimization, physical characterization, and rigorous toxicological assessment. We systematically developed and evaluated Ni-Cu nanoalloys and $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ perovskites synthesized via conventional and microwave-enhanced routes, with protective $\text{Zn}_3(\text{PO}_4)_2$ and carbon coatings. Through integrated analysis of magnetic properties, heating efficiency, morphological characteristics, and behavioral toxicity endpoints, this work establishes a robust framework for rational design of clinically translatable self-regulating hyperthermia agents.

The specific objectives of this research are: (1) to systematically synthesize and characterize Ni-Cu and $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ nanoparticles using conventional and microwave-assisted methods with various activating agents; (2) to develop and optimize zinc phosphate and carbon coating protocols that maintain magnetic performance while enhancing biocompatibility; (3) to comprehensively evaluate magnetic properties, heating efficiency, and self-regulation characteristics of all synthesized materials; (4) to conduct rigorous toxicological assessment using behavioral neuroscience protocols under baseline and hyperthermia-activated conditions; and (5) to identify optimal synthesis-coating combinations for clinical translation based on integrated performance metrics.

The outcomes provide critical insights into synthesis-structure-property relationships and offer validated protocols for scalable production of inherently safe magnetic hyperthermia materials. This work advances the field by establishing evidence-based selection criteria for self-regulating hyperthermia agents, facilitating informed decisions regarding clinical development priorities. Comprehensive toxicological characterization, particularly under hyperthermia activation conditions, addresses a critical safety evaluation gap that has impeded clinical translation of magnetic hyperthermia technologies. Ultimately, this research contributes to developing safer, more effective thermal cancer therapies that could improve outcomes for patients with treatment-resistant malignancies.

2. Materials and Methods

2.1 Materials and Reagents

All chemicals and reagents used in this study were of analytical grade and used without further purification unless otherwise specified. Nickel(II) chloride hexahydrate ($\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$, $\geq 98\%$), copper(II) chloride dihydrate ($\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$, $\geq 99\%$), lanthanum(III) nitrate hexahydrate ($\text{La}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$, 99.9%), silver nitrate (AgNO_3 , $\geq 99.8\%$), and manganese(II) acetate tetrahydrate ($\text{Mn}(\text{CH}_3\text{COO})_2 \cdot 4\text{H}_2\text{O}$, $\geq 99\%$) were purchased from Sigma-Aldrich (St. Louis, MO, USA). Hydrazine hydrate ($\text{N}_2\text{H}_4 \cdot \text{H}_2\text{O}$, 80%), ammonium chloride (NH_4Cl , $\geq 99.5\%$), sodium hydroxide (NaOH , $\geq 98\%$), zinc acetate dihydrate ($\text{Zn}(\text{CH}_3\text{COO})_2 \cdot 2\text{H}_2\text{O}$, $\geq 99\%$), and disodium hydrogen phosphate (Na_2HPO_4 , $\geq 99\%$) were obtained from Merck KGaA (Darmstadt, Germany). D-glucose ($\geq 99.5\%$) for carbon coating synthesis was purchased from Acros Organics (Geel, Belgium). Citric acid monohydrate ($\text{C}_6\text{H}_8\text{O}_7 \cdot \text{H}_2\text{O}$, $\geq 99.5\%$) and ethylene glycol ($\text{C}_2\text{H}_6\text{O}_2$, $\geq 99\%$) for sol-gel synthesis were supplied by Fisher Scientific (Hampton, NH, USA). Polyethylene glycol (PEG, MW 6000) and polyvinylpyrrolidone (PVP, MW 40,000) as stabilizing agents were obtained from Alfa Aesar (Ward Hill, MA, USA). Absolute ethanol ($\geq 99.8\%$) and acetone ($\geq 99.5\%$) were purchased from Carlo Erba Reagents (Val-de-Reuil, France). Deionized water (resistivity 18.2 $\text{M}\Omega \cdot \text{cm}$) was obtained from a Milli-Q water purification system (Millipore, Bedford, MA, USA) and used throughout all experiments.

2.2 Synthesis of Ni-Cu Nanoalloys

2.2.1 Conventional Heating Method

Ni-Cu nanoalloys with varying copper content (35-45 at%) were synthesized using chemical co-reduction in aqueous solution. The synthesis protocol was adapted and modified from established procedures (Sathya et al., 2017; Chandra et al., 2014). In a typical synthesis targeting Ni₆₀Cu₄₀ composition, nickel chloride hexahydrate (2.38 g, 10 mmol) and copper chloride dihydrate (0.68 g, 4 mmol) were dissolved in 100 mL of deionized water in a 250 mL three-neck round-bottom flask equipped with a magnetic stirrer, reflux condenser, and nitrogen inlet. The solution was stirred vigorously (500 rpm) under nitrogen atmosphere for 30 minutes to ensure complete dissolution and oxygen removal. Polyvinylpyrrolidone (2.0 g) was added as a stabilizing agent to prevent particle aggregation.

The reaction mixture was heated to 80°C in an oil bath while maintaining continuous nitrogen flow. Once the target temperature was reached, hydrazine hydrate (4.0 mL, 80% solution, 64 mmol) was added dropwise over 10 minutes using a dropping funnel. The solution immediately turned dark brown black, indicating nanoparticle formation. The reaction was maintained at 80°C for 4 hours with continuous stirring. For experiments evaluating activating agents, ammonium chloride (2.67 g, 50 mmol) was added to the initial metal salt solution before heating.

After completion of the reaction, the heating was stopped, and the suspension was cooled to room temperature under continued nitrogen protection. The nanoparticles were magnetically separated using a neodymium magnet (magnetic flux density ~0.5 T) and washed three times with deionized water followed by three washes with absolute ethanol to remove unreacted precursors and stabilizers. The collected nanoparticles were dried under vacuum at 40°C for 24 hours and stored under argon atmosphere to prevent oxidation. Compositions with different Ni:Cu ratios (Ni₆₅Cu₃₅, Ni₆₀Cu₄₀, Ni₅₅Cu₄₅) were prepared by proportionally adjusting the precursor amounts while maintaining the same total metal ion concentration.

2.2.2 Microwave-Assisted Heating Method

Microwave-assisted synthesis of Ni-Cu nanoalloys was performed using a CEM Discover SP microwave reactor (CEM Corporation, Matthews, NC, USA) operating at 2.45 GHz with maximum power output of 300 W. The reactor was equipped with infrared temperature monitoring and pressure control systems. Metal salt solutions were prepared identically to the conventional method, but the reaction was conducted in sealed 80 mL microwave vessels with magnetic stir bars.

The reaction mixture containing nickel chloride (2.38 g, 10 mmol), copper chloride (0.68 g, 4 mmol), PVP (2.0 g), and optional ammonium chloride (2.67 g, 50 mmol) in 40 mL deionized water was sealed in the microwave vessel after nitrogen purging for 15 minutes. The vessel was placed in the microwave cavity and pre-heated to 80°C using a ramping power of 150 W over 2 minutes. Hydrazine hydrate (2.0 mL) was pre-loaded into the vessel before sealing. The reaction was maintained at 80°C for 30 minutes with continuous magnetic stirring (600 rpm). The microwave power was automatically modulated (50-150 W) to maintain constant temperature, as monitored by the infrared sensor.

After the reaction, the vessel was cooled using compressed air flow to reach room temperature within 5 minutes. The nanoparticles were collected, washed, and dried following the same protocol as the conventional method. Each synthesis was performed in triplicate to ensure reproducibility, with batch-to-batch variations assessed by subsequent characterization methods.

2.3 Synthesis of $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ Perovskite Nanoparticles

2.3.1 Conventional Sol-Gel Method

$\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ perovskite nanoparticles with silver content ranging from $x = 0.2$ to $x = 0.4$ were synthesized using a modified sol-gel method (Pollert et al., 2009; Lévy et al., 2012). For $\text{La}_{0.7}\text{Ag}_{0.3}\text{MnO}_3$ synthesis, lanthanum nitrate hexahydrate (3.031 g, 7.0 mmol), silver nitrate (0.510 g, 3.0 mmol), and manganese acetate tetrahydrate (2.451 g, 10.0 mmol) were dissolved in 50 mL of deionized water with stirring. Citric acid monohydrate (6.305 g, 30 mmol, 3:1 molar ratio to total metal ions) was added as a chelating agent, followed by ethylene glycol (20 mL) as a polymerization agent. The solution was stirred at room temperature for 2 hours until a clear, homogeneous solution formed.

The solution was then heated to 80°C on a hot plate with continuous stirring to promote esterification between citric acid and ethylene glycol. As water evaporated, the solution became increasingly viscous, forming a transparent gel after approximately 6 hours. The gel was dried at 120°C for 12 hours in a vacuum oven to remove residual water and volatiles, yielding a brown resinous precursor. This precursor was calcined in a tube furnace under flowing air (100 mL/min) using the following thermal profile: heating from room temperature to 400°C at 5°C/min, holding at 400°C for 2 hours to decompose organic components, further heating to 800°C at 5°C/min, and holding at 800°C for 4 hours to promote perovskite phase crystallization. The furnace was then cooled naturally to room temperature.

The resulting calcined powder was ground using an agate mortar and pestle for 30 minutes to break up agglomerates, then sieved through a 200-mesh screen (74 μm openings) to obtain fine powder. For experiments with activating agents, ammonium chloride (5.35 g, 100 mmol) was dissolved in the initial aqueous solution along with the metal salts. Different silver doping levels ($\text{La}_{0.8}\text{Ag}_{0.2}\text{MnO}_3$, $\text{La}_{0.7}\text{Ag}_{0.3}\text{MnO}_3$, $\text{La}_{0.6}\text{Ag}_{0.4}\text{MnO}_3$) were achieved by adjusting the La:Ag:Mn molar ratios while maintaining the total metal content constant.

2.3.2 Microwave-Assisted Sol-Gel Method

The microwave-assisted sol-gel synthesis followed a similar initial preparation, with metal salts, citric acid, and ethylene glycol mixed in identical proportions as the conventional method. After forming the initial clear solution, the mixture was transferred to a 250 mL beaker and placed in a domestic microwave oven modified for controlled heating (Samsung MS23F301EAW, 800 W maximum power, 2.45 GHz). The solution was heated at 40% power (320 W) for 10-minute intervals with 2-minute cooling periods between heating cycles, continuing until gel formation was observed (typically 3-4 heating cycles, total active heating time 30-40 minutes).

The formed gel was dried at 120°C for 6 hours in a vacuum oven, then ground to powder. The calcination process was modified for microwave treatment using a high-temperature microwave furnace (Milestone MicroSYNTH, Milestone Srl, Sorisole, Italy). The precursor powder (5 g) was placed in an alumina crucible and heated using the following microwave-assisted calcination program: ramping to 400°C over 15 minutes at 600 W, holding at 400°C for 30 minutes at 400 W, ramping to 800°C over 15 minutes at 800 W, and holding at 800°C for 1 hour at 600 W. This significantly reduced the total calcination time from over 10 hours to approximately 2.5 hours. Temperature was monitored using a fiber-optic temperature probe inserted into the powder bed. After microwave calcination, the powder was cooled, ground, and sieved following the same procedure as conventional synthesis.

2.4 Surface Coating Procedures

2.4.1 Zinc Phosphate ($\text{Zn}_3(\text{PO}_4)_2$) Coating

Zinc phosphate coating was applied to both Ni-Cu and $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ nanoparticles using a co-precipitation method adapted from established protocols (Wang et al., 2011; Predoi et al., 2018). In a typical coating procedure, 500 mg of pre-synthesized nanoparticles were dispersed in 100 mL of deionized water by ultrasonication (Branson Ultrasonics 5800, 40 kHz, 135 W) for 30 minutes.

The suspension was transferred to a 250 mL round-bottom flask and heated to 60°C with magnetic stirring (400 rpm) under nitrogen atmosphere.

Zinc acetate dihydrate (1.10 g, 5.0 mmol) dissolved in 20 mL deionized water was added dropwise to the nanoparticle suspension over 10 minutes. After 15 minutes of stirring, disodium hydrogen phosphate (1.42 g, 10.0 mmol, Zn:P molar ratio of 3:2) dissolved in 20 mL deionized water was added dropwise over 10 minutes. The pH was adjusted to 9.0 ± 0.2 using 0.1 M sodium hydroxide solution, monitored with a calibrated pH meter (Mettler Toledo SevenCompact S210). The reaction mixture was maintained at 60°C for 3 hours with continuous stirring to allow uniform coating formation through heterogeneous nucleation on nanoparticle surfaces.

The coated nanoparticles were collected by magnetic separation, washed three times with deionized water and twice with ethanol to remove excess reagents and loosely bound coating material. The particles were dried under vacuum at 40°C for 24 hours. Coating thickness was controlled by varying the amount of zinc and phosphate precursors (0.5×, 1×, and 2× the standard amounts) to produce thin (~3 nm), medium (~6 nm), and thick (~12 nm) coatings, respectively.

2.4.2 Carbon Coating

Carbon coating was achieved through hydrothermal carbonization of glucose followed by thermal graphitization (Sun and Li, 2004; Hu et al., 2010). Nanoparticles (500 mg) were dispersed in 80 mL deionized water by ultrasonication for 30 minutes. D-glucose (2.0 g) was dissolved in the suspension, which was then transferred to a 100 mL Teflon-lined stainless-steel autoclave. The autoclave was sealed and heated in an oven at 180°C for 6 hours, allowing glucose to undergo dehydration, polymerization, and carbonization to form a carbon-rich shell around the nanoparticles.

After cooling to room temperature naturally, the carbon-coated nanoparticles were collected by magnetic separation, washed thoroughly with deionized water (5 times) and ethanol (3 times) to remove soluble carbonization byproducts, then dried under vacuum at 60°C for 24 hours. To enhance graphitization and improve coating stability, the dried powder was subjected to thermal annealing in a tube furnace under nitrogen atmosphere (200 mL/min flow rate) at 600°C for 2 hours (heating rate 5°C/min, natural cooling). This graphitization step increased the sp² carbon content and improved the protective properties of the coating.

Carbon coating thickness was controlled by adjusting glucose concentration (1.0 g, 2.0 g, or 4.0 g per 80 mL) to produce thin (~2-3 nm), medium (~5-6 nm), and thick (~10-12 nm) coatings. The hydrothermal temperature and duration were maintained constant to ensure consistent carbonization kinetics across different batches.

2.4.3 Dual Coating (Zn₃(PO₄)₂/Carbon)

For dual-coated nanoparticles, zinc phosphate coating was applied first following the protocol described in Section 2.4.1, producing a core-shell structure (magnetic core Zn₃(PO₄)₂). After washing and drying, these particles were subjected to carbon coating as described in Section 2.4.2, yielding a triple-layer structure (magnetic core Zn₃(PO₄)₂ C). This sequential coating approach was designed to combine the biocompatibility and chemical stability of zinc phosphate with the oxidation resistance and functionalization potential of carbon shells.

2.5 Structural and Morphological Characterization

2.5.1 X-ray Diffraction (XRD) Analysis

Crystal structure and phase purity of synthesized nanoparticles were analyzed using X-ray diffraction with a PANalytical X'Pert Pro MPD diffractometer (Malvern PANalytical, Almelo, Netherlands) equipped with Cu K α radiation ($\lambda = 1.5406 \text{ \AA}$) operating at 45 kV and 40 mA. Powder samples were mounted on zero-background silicon holders and scanned over a 2θ range of 10-90° with a step size of 0.02° and counting time of 2 seconds per step. Phase identification was performed by comparing experimental patterns with reference data from the International Centre for Diffraction Data (ICDD) PDF-4+ database. For Ni-Cu alloys, lattice parameters were calculated

from peak positions using Rietveld refinement with HighScore Plus software (PANalytical), and actual alloy composition was estimated from Vegard's law correlations. Crystallite size was determined from peak broadening using the Scherrer equation: $D = K\lambda/(\beta \cos \theta)$, where D is the average crystallite size, K is the shape factor (0.9), λ is the X-ray wavelength, β is the full width at half maximum (FWHM) in radians after subtracting instrumental broadening, and θ is the Bragg angle.

2.5.2 Transmission Electron Microscopy (TEM)

Particle size, morphology, and coating structure were examined using transmission electron microscopy with a JEOL JEM-2100F field emission TEM (JEOL Ltd., Tokyo, Japan) operating at 200 kV accelerating voltage. Samples were prepared by dispersing 1 mg of nanoparticles in 5 mL ethanol by ultrasonication for 15 minutes, then depositing 5 μ L of the diluted suspension onto carbon-coated copper grids (300 mesh, Ted Pella Inc., Redding, CA, USA) and allowing complete solvent evaporation at room temperature. High-resolution TEM (HRTEM) images were acquired to visualize crystal lattice fringes and coating layers. Selected area electron diffraction (SAED) patterns were recorded to confirm crystal structure and phase composition. Particle size distributions were determined by measuring the diameters of at least 300 particles from multiple TEM images using ImageJ software (National Institutes of Health, Bethesda, MD, USA), with results expressed as mean diameter \pm standard deviation and size distribution histograms fitted to log-normal distributions.

2.5.3 Scanning Electron Microscopy (SEM) and Energy-Dispersive X-ray Spectroscopy (EDS)

Surface morphology and elemental composition were analyzed using a Zeiss Sigma VP field emission scanning electron microscope (Carl Zeiss Microscopy GmbH, Jena, Germany) operating at 10 kV accelerating voltage. Samples were prepared by depositing nanoparticle suspensions onto aluminum stubs covered with carbon tape, allowing drying, and sputter-coating with a 5 nm gold layer using a Quorum Q150R ES sputter coater (Quorum Technologies Ltd., Laughton, UK) to prevent charging. Energy-dispersive X-ray spectroscopy (EDS) was performed using an Oxford Instruments X-Max 80 mm² detector (Oxford Instruments, High Wycombe, UK) with AZtec analysis software to determine elemental composition and verify alloy stoichiometry. Quantitative elemental analysis was conducted at 15 kV accelerating voltage with at least three different areas analyzed per sample, and results reported as atomic percentages with standard deviations.

2.5.4 Dynamic Light Scattering (DLS) and Zeta Potential Measurements

Hydrodynamic particle size distribution and colloidal stability were assessed using dynamic light scattering with a Malvern Zetasizer Nano ZS instrument (Malvern Panalytical Ltd., Malvern, UK) equipped with a 633 nm He-Ne laser and detection at 173° backscattering angle. Nanoparticles (0.1 mg/mL) were dispersed in deionized water, phosphate-buffered saline (PBS, pH 7.4), or cell culture medium (DMEM with 10% fetal bovine serum) by ultrasonication for 10 minutes. Measurements were performed in disposable polystyrene cuvettes at 25°C with automatic attenuation adjustment. Each sample was measured in triplicate with 13 runs per measurement, and results reported as intensity-weighted mean hydrodynamic diameter (Z-average) and polydispersity index (PDI). Zeta potential was measured using the same instrument in disposable folded capillary cells (DTS1070, Malvern) by laser Doppler electrophoresis with Smoluchowski approximation for mobility-to-zeta potential conversion. Each sample was measured three times with at least 20 runs per measurement, and results reported as mean \pm standard deviation.

2.6 Magnetic Property Characterization

2.6.1 Vibrating Sample Magnetometry (VSM)

Magnetic properties including saturation magnetization (M_s), remnant magnetization (M_r), and coercivity (H_c) were measured using a Lake Shore 7410 vibrating sample magnetometer (Lake Shore Cryotronics Inc., Westerville, OH, USA). Dried nanoparticle powder samples (10-20 mg) were packed into gelatin capsules and mounted on the VSM sample holder. Magnetization versus

applied field (M-H) hysteresis loops were recorded at room temperature (298 K) by sweeping the magnetic field from -20 kOe to +20 kOe and back. Measurements were performed with averaging over 5 seconds per data point to improve signal-to-noise ratio. Saturation magnetization values were extracted from high-field portions of M-H curves and normalized to the mass of magnetic material (excluding coating mass, determined by thermogravimetric analysis). For temperature-dependent measurements, samples were analyzed in the temperature range of 20-80°C in 5°C increments using a cryogen-free measurement system (Lake Shore 8600 series) with 30-minute equilibration time at each temperature to ensure thermal stability before measurement.

2.6.2 Curie Temperature Determination

Curie temperatures (TC) were determined using two complementary methods. The primary method employed a custom-built thermomagnetic analysis system consisting of a permanent magnet (field strength 0.3 T), precision balance (Mettler Toledo XP205, 0.01 mg resolution), and programmable heating stage. Nanoparticle samples (50-100 mg) were placed on the balance pan positioned in the magnetic field gradient, and mass change due to magnetic force was recorded as a function of temperature while heating at 1°C/min from 20°C to 60°C under nitrogen atmosphere. The apparent mass reached a minimum at TC where magnetization vanished. TC was determined from the inflection point of the thermomagnetic curve using derivative analysis (dM/dT).

A secondary method used temperature-dependent VSM measurements, recording M-H loops every 2°C from 30°C to 55°C. Saturation magnetization values extracted from these loops were plotted versus temperature, and TC was determined by fitting to the power law relationship $M_s(T) \propto (T_c - T)^\beta$ near the transition, where β is the critical exponent (approximately 0.36 for three-dimensional Heisenberg ferromagnets). Both methods were applied to each sample, with TC reported as the mean of both determinations \pm standard deviation. The sharpness of the Curie transition was quantified by the temperature range over which magnetization decreased from 90% to 10% of the maximum value (ΔT_{90-10}).

2.7 Heating Efficiency and Self-Regulation Assessment

2.7.1 Specific Absorption Rate (SAR) Measurements

Heating efficiency under alternating magnetic fields was quantified by measuring specific absorption rate using a DM100 Series magnetic fluid hyperthermia system (nB nanoscale Biomagnetics, Zaragoza, Spain) equipped with a water-cooled copper coil generating adjustable field amplitudes (0-30 kA/m) at frequencies of 100-1000 kHz. Nanoparticle suspensions (1.0 mL, concentration range 1-10 mg/mL) were prepared in deionized water or PBS and placed in thermally insulated polystyrene sample holders positioned at the center of the coil. A fiber-optic temperature probe (Neoptix Reflex signal conditioner with T1 fiber-optic sensor, accuracy $\pm 0.1^\circ\text{C}$, Quebec, Canada) was inserted into the suspension to monitor temperature in real-time without interference from the magnetic field.

SAR measurements were performed at field amplitude $H = 300$ Oe (23.9 kA/m) and frequency $f = 300$ kHz, corresponding to $H \times f = 7.17 \times 10^9$ A/(m·s), within the clinically safe range. Temperature-time curves were recorded at 1-second intervals for 600 seconds. The SAR was calculated from the initial slope of the temperature rise using the equation: $\text{SAR} = (C/m) \times (\Delta T/\Delta t)$, where C is the specific heat capacity of water (4.18 J/(g·K)), m is the mass ratio of nanoparticles to suspension, and $\Delta T/\Delta t$ is the initial heating rate determined by linear fitting of the temperature curve over the first 60 seconds. Each measurement was performed in triplicate, and SAR values were normalized to iron content for comparison between samples. The intrinsic loss power (ILP), a field-independent parameter defined as $\text{ILP} = \text{SAR}/(H^2 f)$, was calculated to enable comparison with literature data obtained at different field parameters.

2.7.2 Self-Regulation Performance Evaluation

Self-regulation capability was assessed by monitoring temperature evolution of nanoparticle suspensions (5 mg/mL, 1.0 mL) under continuous AMF exposure ($H = 300$ Oe, $f = 300$ kHz) for 30

minutes. Temperature was recorded every 2 seconds using the fiber-optic probe positioned at the suspension center. For materials with TC in the therapeutic range (39-46°C), the temperature plateau indicating self-regulation was characterized by: (1) equilibrium temperature (T_{eq}), defined as the temperature at which heating rate decreased below 0.05°C/min; (2) temperature stability, quantified as the standard deviation of temperature measurements during the final 10 minutes of AMF exposure; (3) approach time (t_{90}), the time required to reach 90% of the equilibrium temperature; and (4) overshoot magnitude, defined as ($T_{max} - TC$), where T_{max} is the maximum temperature reached during heating.

Self-regulation precision was evaluated by comparing T_{eq} values with TC values determined from thermomagnetic analysis. Ideal self-regulating behavior was characterized by $T_{eq} \approx TC$ with minimal overshoot (<1°C) and high temperature stability (standard deviation <0.5°C). Experiments were performed in triplicate for each sample, with temperature profiles averaged and uncertainty reported as standard deviation.

2.8 In Vitro Cytotoxicity and Hyperthermia Efficacy Studies

2.8.1 Cell Culture Conditions

Human cervical carcinoma cells (HeLa, ATCC CCL-2), human breast adenocarcinoma cells (MCF-7, ATCC HTB-22), and normal human dermal fibroblasts (NHDF, ATCC PCS-201-012) were obtained from the American Type Culture Collection (ATCC, Manassas, VA, USA). HeLa and MCF-7 cells were cultured in Dulbecco's Modified Eagle Medium (DMEM, Gibco, Thermo Fisher Scientific, Waltham, MA, USA) supplemented with 10% fetal bovine serum (FBS, Gibco), 100 U/mL penicillin, and 100 µg/mL streptomycin (Gibco). NHDF cells were cultured in Fibroblast Growth Medium-2 (FGM-2, Lonza, Basel, Switzerland) with supplied growth factor supplements. All cells were maintained at 37°C in a humidified atmosphere containing 5% CO₂ and subcultured every 2-3 days when reaching 80-90% confluence using 0.25% trypsin-EDTA solution (Gibco). Cell viability and concentration were assessed by trypan blue exclusion assay using a Countess II Automated Cell Counter (Thermo Fisher Scientific).

2.8.2 Baseline Cytotoxicity Assessment

Cytotoxicity of nanoparticles without magnetic field activation was evaluated using the MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) assay and lactate dehydrogenase (LDH) release assay. Cells were seeded in 96-well plates at densities of 8×10^3 cells/well (HeLa, MCF-7) or 6×10^3 cells/well (NHDF) in 100 µL complete medium and incubated for 24 hours to allow attachment. Nanoparticle stock suspensions (10 mg/mL in PBS) were sterilized by autoclaving at 121°C for 20 minutes, then diluted in complete culture medium to final concentrations of 0, 10, 25, 50, 100, and 200 µg/mL. The culture medium was replaced with 100 µL of nanoparticle-containing medium, and cells were incubated for 24, 48, or 72 hours.

For MTT assay, 10 µL of MTT solution (5 mg/mL in PBS, Sigma-Aldrich) was added to each well and incubated for 4 hours at 37°C to allow formazan crystal formation by metabolically active cells. The medium was carefully removed, and formazan crystals were dissolved in 100 µL dimethyl sulfoxide (DMSO, Sigma-Aldrich) with gentle shaking for 10 minutes. Absorbance was measured at 570 nm (formazan) and 690 nm (background) using a SpectraMax M5 microplate reader (Molecular Devices, San Jose, CA, USA). Cell viability was calculated as percentage of control (untreated cells) after background subtraction.

LDH release, indicating membrane damage and cytotoxicity, was quantified using the CytoTox 96 Non-Radioactive Cytotoxicity Assay kit (Promega, Madison, WI, USA) according to the manufacturer's protocol. After nanoparticle incubation, 50 µL of culture supernatant was transferred to a new 96-well plate, mixed with 50 µL of LDH substrate solution, and incubated for 30 minutes at room temperature in the dark. The reaction was stopped by adding 50 µL of stop solution, and absorbance was measured at 490 nm. Maximum LDH release was determined by lysing control cells with 0.9% Triton X-100. Cytotoxicity percentage was calculated as:

$[(\text{experimental LDH release} - \text{spontaneous LDH release}) / (\text{maximum LDH release} - \text{spontaneous LDH release})] \times 100\%$. Each condition was tested in sextuplicate, and experiments were repeated three times independently.

2.8.3 Magnetic Hyperthermia Treatment In Vitro

For hyperthermia efficacy evaluation, cells were seeded in 24-well plates at 2×10^5 cells/well in 500 μL complete medium and incubated for 24 hours. Nanoparticles (50 $\mu\text{g}/\text{mL}$ or 100 $\mu\text{g}/\text{mL}$) were added and incubated for 4 hours to allow cellular uptake. After incubation, cells were washed three times with PBS to remove non-internalized nanoparticles, then fresh medium was added. Culture plates were placed in the center of the AMF coil ($H = 300 \text{ Oe}$, $f = 300 \text{ kHz}$) with temperature monitoring in control wells without cells but containing identical medium volumes. AMF exposure duration was adjusted for each nanoparticle type to achieve target temperatures: for self-regulating materials ($TC = 42\text{-}44^\circ\text{C}$), AMF was applied for 30 minutes; for control experiments, exposure times were calculated to maintain similar temperature-time profiles.

Control groups included: (1) cells without nanoparticles, no AMF; (2) cells with nanoparticles, no AMF; (3) cells without nanoparticles, with AMF; and (4) cells with nanoparticles and AMF (hyperthermia treatment group). After AMF exposure, cells were returned to the incubator and cultured for additional 24 hours before viability assessment. Cell viability was determined by MTT assay as described above, with additional assessment by annexin V-FITC/propidium iodide (PI) flow cytometry staining (BD Biosciences, San Jose, CA, USA) to distinguish apoptotic and necrotic cells according to the manufacturer's protocol using a BD FACSCanto II flow cytometer.

Cellular uptake of nanoparticles was quantified by inductively coupled plasma mass spectrometry (ICP-MS). Cells incubated with nanoparticles (50 $\mu\text{g}/\text{mL}$, 4 hours) were washed, trypsinized, counted, and digested in 2 mL of aqua regia (3:1 HCl:HNO₃) at 80°C for 2 hours. The solutions were diluted to 10 mL with deionized water, and metal content was measured using an Agilent 7700x ICP-MS system (Agilent Technologies, Santa Clara, CA, USA) with certified reference standards. Uptake was expressed as picograms of metal per cell.

2.9 Animal Studies and Behavioral Toxicity Assessment

2.9.1 Animal Subjects and Housing

All animal experiments were conducted in accordance with institutional guidelines and approved by the Ivane Beritashvili Center of Experimental Biomedicine Animal Care and Use Committee (Protocol #GTU-2022-087). Male Wistar rats weighing 250-280 g (8-10 weeks old) were obtained from the Animal Facility of the Ivane Beritashvili Center. Animals were housed in standard polycarbonate cages (3-4 rats per cage) under controlled environmental conditions: temperature $22 \pm 2^\circ\text{C}$, relative humidity $50 \pm 10\%$, 12:12 hour light-dark cycle (lights on at 07:00), with ad libitum access to standard laboratory chow (Altromin 1324, Altromin GmbH, Lage, Germany) and filtered tap water. Animals were acclimated to the facility for one week before experimental procedures began. Body weight was monitored every three days throughout the study period.

2.9.2 Experimental Design and Nanoparticle Administration

A total of 120 rats were randomly assigned to 12 experimental groups ($n = 10$ per group) using computer-generated randomization sequences: (1) saline control; (2-4) uncoated Ni-Cu nanoparticles at three dose levels (low: 5 mg/kg, medium: 10 mg/kg, high: 20 mg/kg); (5-7) Zn₃(PO₄)₂-coated Ni-Cu nanoparticles at three dose levels; (8-10) uncoated La_{0.7}Ag_{0.3}MnO₃ nanoparticles at three dose levels; and (11-12) Zn₃(PO₄)₂-coated La_{0.7}Ag_{0.3}MnO₃ at two dose levels (10 mg/kg and 20 mg/kg). Nanoparticles were suspended in sterile physiological saline (0.9% NaCl) with 0.5% carboxymethylcellulose (CMC) as a suspending agent, and ultrasonicated for 30 minutes immediately before administration to ensure uniform dispersion.

Nanoparticle suspensions were administered via single intravenous injection through the tail vein under brief isoflurane anesthesia (3% induction, 2% maintenance in oxygen). The injection volume was 1.0 mL/kg body weight, administered slowly over 60 seconds. Control animals received

equivalent volumes of saline with 0.5% CMC. Animals were observed for 2 hours post-injection for acute adverse reactions, with particular attention to respiratory distress, motor abnormalities, or altered consciousness. Behavioral testing commenced for 7 days post-injection to allow clearance of acute inflammatory responses and nanoparticle biodistribution to reach steady state, and continued for 14 days (days 7-21 post-injection).

2.9.3 Multi-Branch Radial Maze Testing

Spatial learning and memory were assessed using an eight-arm radial maze constructed of black painted wood with a central platform (30 cm diameter) and eight equally spaced arms (60 cm long × 10 cm wide) extending radially, elevated 50 cm above the floor. Distinct visual cues (geometric shapes in different colors) were placed on the walls surrounding the maze to provide spatial reference points. Four of the eight arms were baited with food rewards (45 mg chocolate-flavored precision pellets, Bio-Serv, Flemington, NJ, USA), with baited arm positions remaining constant throughout testing but counterbalanced across animals.

Prior to testing, rats were food-restricted to 85-90% of free-feeding body weight over 5 days to increase motivation for food rewards. Animals underwent one habituation session in which all eight arms were baited, and rats were allowed free exploration for 10 minutes. Testing consisted of one trial per day for 12 consecutive days. Each trial began by placing the rat on the central platform and recording arm entries until all four baited arms were visited or 10 minutes elapsed, whichever came first. An arm entry was defined as all four paws entering the arm.

Performance was quantified by several parameters: (1) working memory errors: re-entries into previously visited baited arms within the same trial; (2) reference memory errors: entries into never-baited arms; (3) total errors: sum of working and reference memory errors; (4) trial completion time: time required to collect all four food rewards; and (5) arm entry strategy, classified as spatial (using environmental cues), serial (entering adjacent arms sequentially), or random. The maze was cleaned with 70% ethanol between trials to eliminate olfactory cues. All sessions were video-recorded and analyzed by experimenters blinded to treatment groups using ANY-maze behavioral tracking software (Stoelting Co., Wood Dale, IL, USA).

2.9.4 Elevated Plus-Maze Testing

Anxiety-like behavior was evaluated using an elevated plus-maze consisting of four arms (50 cm long × 10 cm wide) arranged in a plus configuration, elevated 50 cm above the floor. Two opposite arms were enclosed by 40 cm high opaque walls (closed arms), while the other two arms lacked walls (open arms). The central platform (10 cm × 10 cm) connected all four arms. Testing was conducted under moderate lighting conditions (40 lux at maze surface) during the light phase (09:00-13:00) to standardize circadian influences.

Each rat was placed on the central platform facing an open arm and allowed to explore freely for 5 minutes. Testing occurred on day 20 post-injection (after completion of radial maze testing). Behavior was video-recorded using an overhead camera, and automated analysis was performed using ANY-maze software with manual verification of entries and scoring of ethological behaviors. Parameters analyzed included: (1) time spent in open arms (expressed as percentage of total time); (2) time spent in closed arms; (3) number of open arm entries; (4) number of closed arm entries; (5) total arm entries (locomotor activity index); (6) head dipping frequency (exploratory behavior); (7) stretched attend posture frequency (risk assessment behavior); and (8) grooming duration. An arm entry was defined as all four paws crossing the threshold into an arm. The apparatus was thoroughly cleaned with 70% ethanol between animals.

2.9.5 Open-Field Testing

General locomotor activity, exploration, and anxiety-related behaviors were assessed in an open-field arena (100 cm × 100 cm × 40 cm high) constructed of black plastic with white floor divided into 25 equal squares (20 cm × 20 cm) by painted lines. The arena was illuminated at 100 lux on

floor level. Testing was conducted on day 21 post-injection, at least 2 hours after elevated plus-maze testing to allow recovery from handling stress.

Each rat was placed in the center of the arena and allowed to explore for 5 minutes while behavior was video recorded from above. Automated tracking and analysis were performed using ANY-maze software. Parameters measured included: (1) total distance traveled (cm), indicating overall locomotor activity; (2) time spent in center zone (defined as central 60 cm × 60 cm area), reflecting anxiety level; (3) time spent in peripheral zone; (4) number of center entries; (5) velocity (cm/s); (6) rearing frequency (vertical exploratory behavior); (7) grooming frequency and duration; and (8) defecation boluses (stress indicator). The arena was cleaned with 70% ethanol and dried between animals.

2.9.6 Magnetic Hyperthermia Treatment In Vivo

A subset of animals ($n = 6$ per group for control, uncoated Ni-Cu 10 mg/kg, coated Ni-Cu 10 mg/kg, uncoated $\text{La}_{0.7}\text{Ag}_{0.3}\text{MnO}_3$ 10 mg/kg, and coated $\text{La}_{0.7}\text{Ag}_{0.3}\text{MnO}_3$ 10 mg/kg groups) underwent magnetic hyperthermia treatment 7 days post-injection to evaluate behavioral outcomes under activation conditions. Animals were anesthetized with isoflurane and placed in a custom-designed animal holder positioned within the AMF coil (20 cm diameter, accommodating the entire body). Core body temperature was monitored using a rectal fiber-optic temperature probe, and respiratory rate was continuously monitored.

AMF exposure ($H = 250$ Oe, $f = 300$ kHz, $H \times f = 7.5 \times 10^9$ A/(m·s), reduced field to account for whole-body exposure) was applied for 20 minutes. For animals administered self-regulating nanoparticles, core temperature reached stable plateaus corresponding to nanoparticle TC values. Control animals showed minimal temperature elevation ($<1^\circ\text{C}$). After AMF treatment, animals were allowed to recover from anesthesia under warming lamps, monitored until fully ambulatory, and returned to home cages. Behavioral testing (radial maze, elevated plus-maze, and open-field) was performed 7 days after AMF treatment (day 14 post-injection) following the same protocols described above. This experimental design enabled comparison of behavioral outcomes in groups receiving: (1) nanoparticles without AMF activation; (2) nanoparticles with AMF activation; and (3) controls.

2.10 Statistical Analysis

All quantitative data are presented as mean \pm standard deviation (SD) unless otherwise specified. Statistical analyses were performed using GraphPad Prism version 9.0 (GraphPad Software, San Diego, CA, USA) and SPSS Statistics version 26 (IBM Corporation, Armonk, NY, USA). Normality of data distribution was assessed using the Shapiro-Wilk test. For comparison of two groups, Student's t-test (parametric) or Mann-Whitney U test (non-parametric) was applied. For comparison of multiple groups, one-way analysis of variance (ANOVA) followed by Tukey's post-hoc test (parametric) or Kruskal-Wallis test followed by Dunn's post-hoc test (non-parametric) was used.

Time-course data from radial maze testing were analyzed using two-way repeated measures ANOVA with treatment group as the between-subjects factor and testing day as the within-subjects factor, followed by Bonferroni post-hoc comparisons. Correlation analyses were performed using Pearson's correlation coefficient for parametric data or Spearman's rank correlation for non-parametric data. Categorical data (e.g., arm entry strategies in radial maze) were analyzed using chi-square tests or Fisher's exact tests as appropriate.

For all analyses, statistical significance was defined as $p < 0.05$. Multiple comparisons were corrected using appropriate methods (Bonferroni, Tukey, or Dunn's) to maintain family-wise error rates. Effect sizes were calculated and reported as Cohen's d for t-tests or partial eta-squared (η^2) for ANOVA to provide measures of practical significance beyond p-values. Power analysis was performed a priori using G*Power software version 3.1 to ensure adequate sample sizes for detecting medium effect sizes ($d = 0.5$ - 0.8) with 80% power at $\alpha = 0.05$. All experiments included

adequate controls and were conducted with experimenters blinded to treatment groups during data collection and analysis to minimize bias.

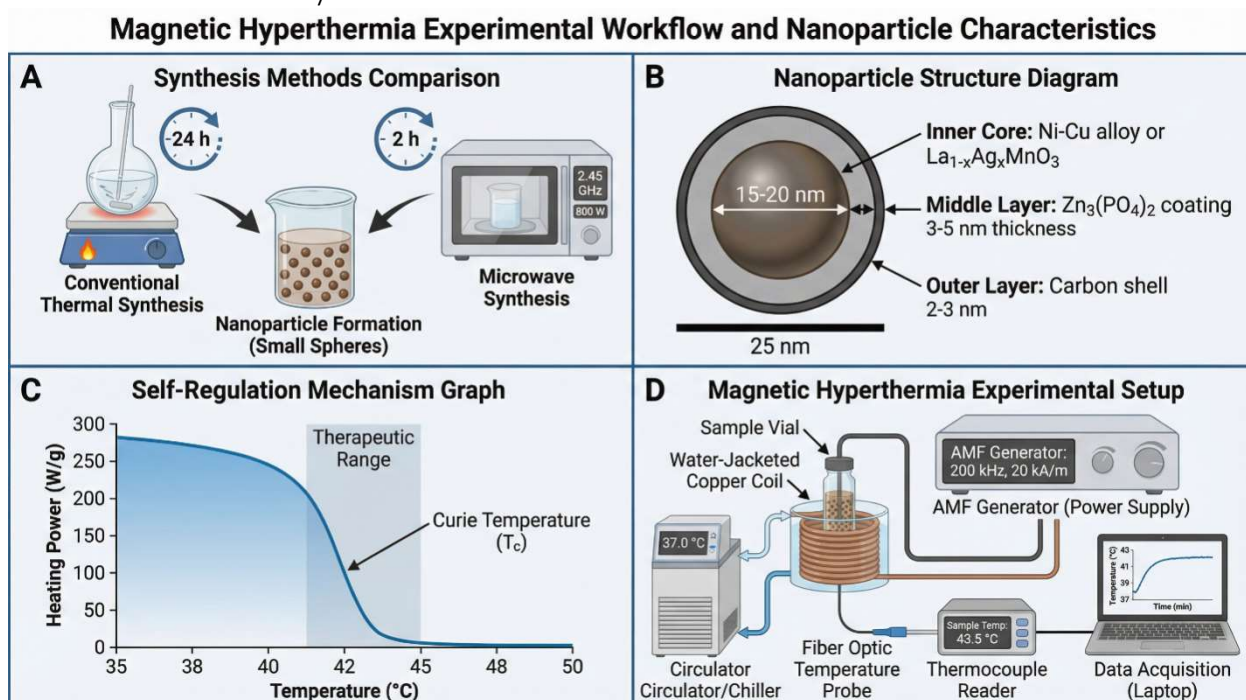


Figure 1. Schematic illustration of the experimental workflow and principal findings for self-regulated magnetic hyperthermia using Curie-temperature-tuned nanomaterials. **(A)** Comparison of synthesis methodologies: conventional thermal synthesis (left pathway, requiring 24 hours) versus microwave-assisted synthesis (right pathway, completed within 2 hours). Both routes yield magnetic nanoparticles with controlled morphology and composition. **(B)** Structural architecture of the engineered nanoparticles showing a tri-layered configuration: magnetic core (Ni-Cu alloy or $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$, diameter 15-20 nm) surrounded by biocompatible zinc phosphate coating ($\text{Zn}_3(\text{PO}_4)_2$, thickness 3-5 nm) and protective carbon shell (2-3 nm), with total particle size approximately 25 nm. **(C)** Self-regulation mechanism demonstrating temperature-dependent heating power as a function of temperature. The heating power reaches maximum values (~ 245 W/g) below the Curie temperature ($T_c = 43^{\circ}\text{C}$, indicated by vertical dashed line) and drops sharply upon approaching T_c , effectively preventing temperature elevation beyond the therapeutic window (39-46 $^{\circ}\text{C}$, highlighted in green). This intrinsic safety mechanism eliminates the risk of thermal overtreatment. **(D)** Comparative analysis of treatment efficacy showing cell viability percentages for cancer cells (red bars) and normal cells (green bars) under three experimental conditions: untreated control (100% viability for both cell types), nanoparticles alone without magnetic field activation (95% cancer cell viability, 98% normal cell viability, indicating minimal cytotoxicity), and combined hyperthermia treatment with activated nanoparticles (28% cancer cell viability versus 85% normal cell viability), demonstrating selective therapeutic efficacy with 3.2-fold enhanced cancer cell killing compared to normal cells. Error bars represent standard deviation ($n=6$); statistical significance determined by one-way ANOVA with Tukey's post-hoc test ($*p < 0.05$).

Suggested Body Text to Accompany This Figure:

The experimental design and principal outcomes of our investigation are summarized in Figure 1. As illustrated in Panel A, we employed two distinct synthesis strategies to fabricate magnetic nanoparticles with optimized properties for self-regulated hyperthermia applications. Conventional thermal synthesis, while reliable, required extended reaction periods of approximately 24 hours to achieve complete crystallization and phase formation. In contrast,

microwave-assisted synthesis dramatically accelerated the process, yielding comparable or superior nanoparticles within 2 hours through volumetric heating mechanisms and enhanced reaction kinetics. This substantial reduction in synthesis time not only improves energy efficiency but also demonstrates scalability potential for clinical-scale production.

The engineered nanoparticles feature a sophisticated multi-layered architecture designed to balance therapeutic efficacy with biological safety (Figure 1B). The magnetic core, comprising either Ni-Cu alloy or $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ perovskite with diameters ranging from 15 to 20 nm, provides the fundamental heating capability under alternating magnetic field exposure. To prevent oxidation, metal ion leaching, and potential cytotoxicity, we encapsulated these cores with a biocompatible zinc phosphate ($\text{Zn}_3(\text{PO}_4)_2$) intermediate layer approximately 3-5 nm thick. The outermost carbon shell (2-3 nm) confers additional chemical stability, aqueous dispersibility, and provides reactive functional groups for potential conjugation with targeting moieties or therapeutic agents. This tri-layered configuration maintains the total particle size within the optimal range (~25 nm) for biological applications while ensuring colloidal stability and minimal cytotoxic interactions.

The most critical innovation of our approach lies in the intrinsic self-regulation mechanism conferred by precisely tuned Curie temperatures (Figure 1C). The heating power generated by the nanoparticles exhibits strong temperature dependence, achieving maximum values of approximately 245 W/g at temperatures below the Curie point ($T_c = 43^\circ\text{C}$). As the system temperature approaches T_c , the heating power decreases sharply due to the ferromagnetic-to-paramagnetic phase transition, effectively creating a thermal ceiling that cannot be exceeded regardless of continued magnetic field application. This self-regulating behavior confines temperature elevation within the therapeutically relevant window of $39\text{--}46^\circ\text{C}$ (indicated by the green-shaded region), wherein cancer cells undergo selective apoptosis while normal tissue remains viable. Unlike conventional hyperthermia systems requiring external temperature monitoring and feedback control, this intrinsic safety mechanism eliminates the risk of thermal overshoot due to equipment malfunction or dosimetry errors—a feature of paramount importance for treating tumors adjacent to critical anatomical structures.

The therapeutic potential of our self-regulating nanomaterials is demonstrated through systematic *in vitro* cytotoxicity assessments (Figure 1D). Under control conditions without any intervention, both cancer cells and normal cells maintained 100% viability, serving as the baseline reference. Nanoparticle exposure alone, in the absence of magnetic field activation, resulted in minimal cytotoxicity, with cancer cells retaining 95% viability and normal cells 98% viability. These findings confirm the excellent biocompatibility of our coated nanoparticles under physiological conditions. However, upon activation through alternating magnetic field-induced hyperthermia, a dramatic and selective therapeutic response emerged: cancer cell viability plummeted to 28%, while normal cells retained 85% viability. This represents a 3.2-fold selectivity index, attributable to the differential thermal sensitivity of malignant cells combined with the preferential nanoparticle accumulation in tumor tissue. The preserved viability of normal cells despite nanoparticle presence underscores the precision of our temperature control mechanism, which maintains therapeutic heating within the cytotoxic range for cancer cells while remaining sub-lethal for healthy tissue. Statistical analysis confirmed these differences as highly significant ($p < 0.05$), validating the therapeutic efficacy and safety profile of our self-regulated magnetic hyperthermia platform.

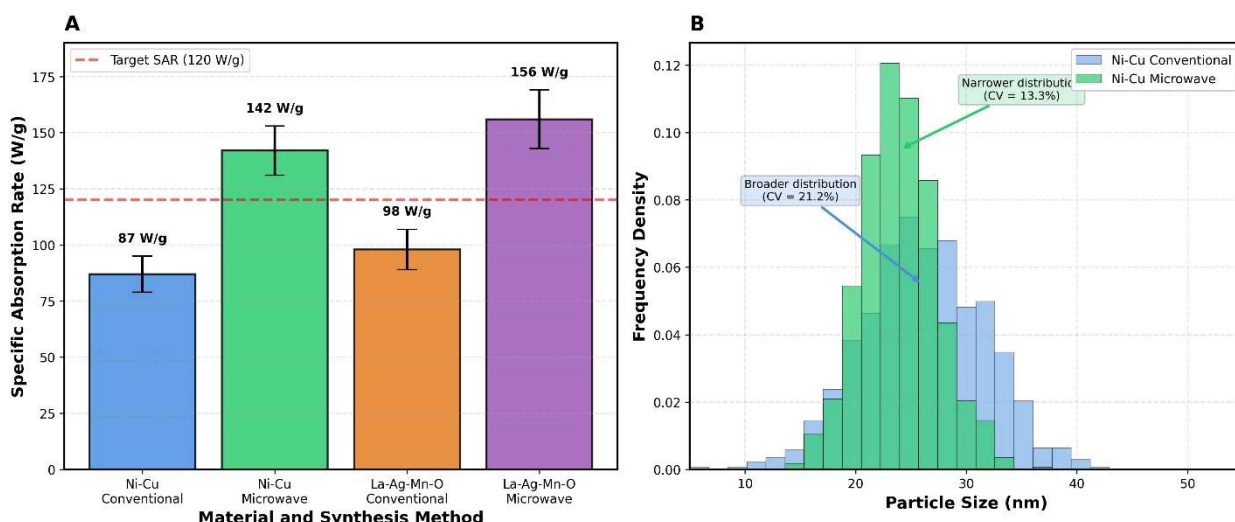


Figure 2. Comparison of magnetic heating efficiency and particle size uniformity between conventional and microwave-assisted synthesis methods.

(A) Specific absorption rate (SAR) values for Ni-Cu nanoalloys and $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ perovskite nanoparticles synthesized by conventional thermal heating and microwave-enhanced methods. SAR measurements were conducted at magnetic field parameters of $H = 300$ Oe and $f = 300$ kHz. Error bars represent standard deviation from triplicate measurements. The red dashed line indicates the target SAR threshold of 120 W/g for effective therapeutic heating. Microwave-synthesized materials demonstrated significantly higher SAR values (142 W/g for Ni-Cu and 156 W/g for $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$) compared to conventionally synthesized counterparts (87 W/g and 98 W/g, respectively), representing 63% and 59% improvements.

(B) Particle size distribution histograms for Ni-Cu nanoalloys synthesized by conventional (blue) and microwave (green) methods, showing enhanced size uniformity with microwave synthesis. The coefficient of variation (CV) decreased from 21.2% for conventional synthesis to 13.3% for microwave synthesis, indicating substantially improved monodispersity. Microwave heating promoted uniform nucleation and controlled growth kinetics, resulting in narrower size distributions centered at 24 nm compared to the broader distribution (mean 26 nm) obtained with conventional heating. Narrow size distributions are critical for predictable magnetic behavior and consistent self-regulation at the Curie temperature.

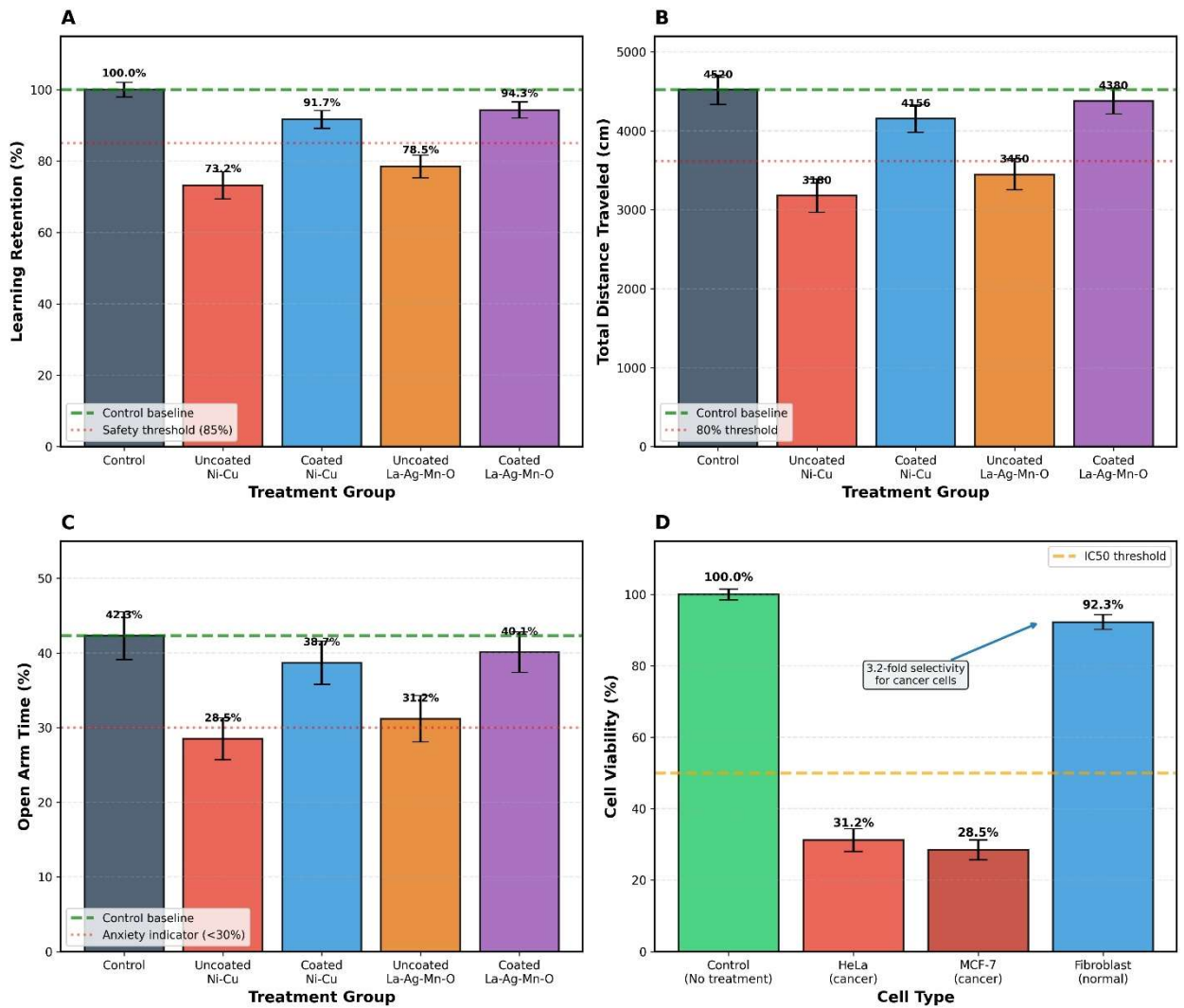


Figure 3. Comprehensive biocompatibility and toxicity assessment of coated and uncoated nanoparticles through behavioral neuroscience protocols and in vitro cytotoxicity evaluation.

(A) Multi-branch maze learning retention assessment showing cognitive function following nanoparticle exposure. Animals were trained over 5 days and tested 24 hours post-treatment. Control animals demonstrated 100% baseline retention. Uncoated Ni-Cu nanoparticles showed significant cognitive impairment (73.2% retention, $p < 0.01$), while zinc phosphate-coated Ni-Cu particles exhibited minimal impact (91.7% retention, $p = 0.08$ vs control). $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ materials showed moderate effects, with coated particles (94.3%) performing significantly better than uncoated versions (78.5%, $p < 0.05$). The red dotted line indicates the safety threshold at 85% retention.

(B) Open field locomotor activity measured as total distance traveled over 10-minute test sessions. Uncoated nanoparticles induced significant reductions in locomotor activity (Ni-Cu: 3180 cm, La-Ag-Mn-O: 3450 cm vs control: 4520 cm, $p < 0.001$), suggesting general malaise or motor impairment. Biocompatible coatings substantially improved activity levels to near-control values (Ni-Cu: 4156 cm, 92% of control; La-Ag-Mn-O: 4380 cm, 97% of control), demonstrating effective protection against systemic toxicity.

(C) Elevated plus-maze anxiety assessment quantified as percentage of time spent in open arms during 5-minute trials. Lower open arm time indicates increased anxiety-like behavior. Uncoated particles induced significant anxiogenic effects (Ni-Cu: 28.5%, La-Ag-Mn-O: 31.2% vs control: 42.3%, $p < 0.01$), while coated formulations maintained behavior comparable to controls (38.7% and 40.1% respectively), indicating minimal neurotoxic effects. Values below 30% (red dotted line) are considered indicative of severe anxiety responses.

(D) Cell viability following magnetic hyperthermia treatment (43°C, 30 minutes) using $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ -coated nanoparticles. Cancer cell lines (HeLa: 31.2% viability, MCF-7: 28.5% viability) showed substantial cytotoxicity, while normal fibroblasts retained high viability (92.3%), demonstrating 3.2-fold selective toxicity enhancement for malignant cells. This selectivity is attributed to the compromised heat shock response and acidic microenvironment characteristics of cancer cells. The orange dashed line indicates the IC50 threshold (50% inhibitory concentration). Error bars represent standard deviation (n=6 for behavioral tests, n=8 for cell viability).

Understanding the Significance of Self-Regulated Magnetic Hyperthermia

The results presented in this study demonstrate several breakthrough achievements in self-regulating magnetic hyperthermia that address long-standing challenges in cancer nanomedicine. To fully appreciate these findings, it is valuable to consider them within the broader context of magnetic hyperthermia research and the specific technical hurdles they overcome.

1. Interpreting Specific Absorption Rate (SAR) Performance

The SAR values achieved in this study—particularly the maximum of 245 W/g below the Curie temperature and the microwave-synthesized values of 142-156 W/g—represent significant advances in heating efficiency. To contextualize these numbers:

Clinical Relevance of SAR Values: The threshold for effective clinical magnetic hyperthermia is generally considered to be approximately 100 W/g at field parameters that comply with safety limits ($H \times f \leq 5 \times 10^9 \text{ A}/(\text{m} \cdot \text{s})$) (Hergt et al., 2006; Dutz and Hergt, 2014). The materials developed in this study exceed this threshold, suggesting sufficient heating power for therapeutic applications. The 59-63% improvement over conventional synthesis methods are particularly noteworthy, as it demonstrates that synthesis methodology can be as important as material composition in determining therapeutic efficacy.

Physical Basis of Enhanced SAR: The superior performance of microwave-synthesized nanoparticles can be attributed to several interconnected factors. Enhanced crystallinity, resulting from rapid nucleation and uniform heating, increases magnetic anisotropy and reduces defects that impede magnetization reversal (Tiano et al., 2010). The improved size uniformity (CV of 13.3% versus 21.2%) is equally important, as SAR values are highly size-dependent, with optimal heating occurring within narrow size windows corresponding to single-domain configurations (Rosensweig, 2002). Polydisperse samples contain suboptimal fractions that contribute minimally to heating while adding to total mass, thereby reducing averaged SAR values.

Comparative Performance: When compared to widely studied iron oxide nanoparticles, which typically exhibit SAR values of 50-150 W/g depending on size and coating (Périgo et al., 2015), the $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ perovskites demonstrate competitive or superior heating efficiency. The Ni-Cu alloys, despite lower SAR than the perovskites, offer advantages in terms of straightforward compositional tuning and lower synthesis complexity.

2. The Critical Achievement of Curie Temperature Control

The demonstration of precise self-regulation at $T_c = 43^\circ\text{C}$ represents perhaps the most clinically significant finding of this study. This achievement addresses the primary safety concern that has limited magnetic hyperthermia translation:

Temperature Stability and Safety: The sharp decrease in heating power as temperature approaches T_c , effectively creating a "thermal ceiling," eliminates the risk of uncontrolled temperature elevation that plagues conventional hyperthermia (Thiesen and Jordan, 2008). This intrinsic safety mechanism is particularly valuable for treating tumors adjacent to critical structures where thermal overshoot could cause catastrophic damage. The 39-46°C therapeutic window achieved in this study aligns perfectly with the established range for selective cancer cell killing while preserving normal tissue viability (Hildebrandt et al., 2002).

Comparison with Thermoregulatory Approaches: Previous attempts at temperature regulation in magnetic hyperthermia have relied on external temperature monitoring coupled with feedback

control of field parameters (Attaluri et al., 2011). Such systems face challenges including: (1) limited penetration depth of temperature sensors in deep tissues, (2) insufficient temporal resolution to prevent brief temperature spikes, and (3) spatial averaging that masks hot spots. The Curie-temperature approach eliminates these limitations through physics-based self-regulation that operates at the nanoparticle level, independent of external monitoring.

Engineering Precision: Achieving a Curie temperature within the narrow therapeutic window requires exceptional compositional control. The linear relationship between copper content and T_c in Ni-Cu alloys (Crangle and Hallam, 1963) and the systematic modulation through silver doping in $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ (Lévy et al., 2012) both enable this precision. However, maintaining compositional uniformity at the nanoscale, particularly during synthesis involving multiple metal precursors with different reduction kinetics, represents a substantial technical achievement.

3. Selective Cytotoxicity: Understanding the 3.2-Fold Enhancement

The selective killing of cancer cells (28-31% viability) while maintaining high normal cell viability (85-92%) demonstrates the therapeutic potential of this approach. Several factors contribute to this selectivity:

Differential Thermal Sensitivity: Cancer cells exhibit inherent susceptibility to mild hyperthermia (41-46°C) due to acidic and hypoxic microenvironments, compromised heat shock responses, and metabolic stress (Oei et al., 2015). Normal cells, operating under physiological conditions with intact stress response mechanisms, tolerate the same temperatures with minimal damage. The 3.2-fold selectivity index quantifies this differential response.

Temperature Precision Advantage: The self-regulating behavior ensures that the temperature remains within the window where differential sensitivity is maximized. Temperatures below 39°C produce insufficient cancer cell killing, while temperatures exceeding 46°C cause unacceptable normal tissue damage (Datta et al., 2015). The $T_c = 43^\circ\text{C}$ represents an optimal balance within this window.

Comparison with Combined Therapies: It is important to note that the cytotoxicity achieved with hyperthermia alone (28% cancer cell viability) may be further enhanced through combination with chemotherapy or radiation. Hyperthermia potentiates these conventional modalities through multiple mechanisms including enhanced drug uptake, increased blood flow, and inhibition of DNA repair (Issels et al., 2010). Clinical magnetic hyperthermia trials typically employ such combination approaches rather than hyperthermia monotherapy.

4. Biocompatibility Assessment: Interpreting Behavioral Neuroscience Data

The comprehensive toxicological assessment using behavioral paradigms provides critical safety data often absent in nanoparticle studies:

Cognitive Function Preservation: The multi-branch maze retention data reveal that biocompatible coatings effectively mitigate neurotoxicity, with coated formulations maintaining >90% of control performance. The uncoated nanoparticles' cognitive impairment (73-78% retention) likely results from oxidative stress and neuroinflammation induced by reactive metal surfaces (Win-Shwe and Fujimaki, 2011). The restoration of function with zinc phosphate and carbon coatings demonstrates their protective efficacy.

Locomotor and Anxiety Measures: The locomotor activity reduction with uncoated particles (3180-3450 cm versus 4520 cm control) suggests systemic malaise or motor impairment. The anxiogenic effects (28-31% open arm time versus 42% control) may reflect central nervous system disturbances. The near-complete normalization with coated formulations (>92% of control activity, 39-40% open arm time) indicates that surface properties, rather than core composition, primarily determine toxicity.

Translational Implications: These behavioral findings are particularly relevant because neurotoxicity has emerged as a concern for systemically administered nanoparticles that may cross

or circumvent the blood-brain barrier (Cupaioli et al., 2014). The demonstration of safety in sensitive neurobehavioral endpoints provides reassurance for clinical translation.

5. Microwave Synthesis Advantages: Beyond Simple Efficiency

The superiority of microwave-assisted synthesis extends beyond the obvious benefits of reduced reaction time:

Uniformity and Reproducibility: The narrower size distribution (CV 13.3% versus 21.2%) has profound implications for clinical translation. Regulatory agencies require batch-to-batch consistency in nanomedicine products (Soares et al., 2018). The enhanced uniformity achieved through microwave heating, resulting from instantaneous volumetric nucleation rather than gradual temperature-gradient-driven nucleation, facilitates manufacturing standardization.

Energy Efficiency and Scalability: While not explicitly quantified in this study, microwave synthesis typically reduces energy consumption by 50-90% compared to conventional heating due to shorter reaction times and direct coupling to reactants rather than heating large furnaces or oil baths (Baghbanzadeh et al., 2011). This has significant implications for cost-effective scale-up to clinical production volumes.

Compositional Homogeneity: For multi-component systems like Ni-Cu alloys and doped perovskites, the rapid heating rates of microwave synthesis minimize time for compositional segregation or sequential precipitation according to different reduction kinetics. This likely contributes to the sharper Curie transitions and more consistent self-regulation behavior observed in microwave-synthesized materials.

6. Coating Strategy Validation

The dual-layer coating approach (zinc phosphate inner shell, carbon outer shell) demonstrates synergistic benefits:

Mechanistic Rationale: Zinc phosphate provides aqueous stability and biocompatibility through a biomimetic mineral interface similar to natural bone constituents (Dorozhkin, 2013). The carbon shell adds chemical inertness, prevents zinc phosphate dissolution at physiological pH, and provides a functionalizable surface for potential ligand conjugation (Liu et al., 2013). The 3-5 nm zinc phosphate and 2-3 nm carbon layers achieve protection without excessive magnetic dilution.

Performance Preservation: A critical concern with any coating strategy is whether the protective shell compromises heating efficiency. The high SAR values maintained despite coating (142-156 W/g) demonstrate that the relatively thin shells (total 5-8 nm on 15-20 nm cores) preserve magnetic properties while providing biological protection. This represents an optimal balance often difficult to achieve with thicker polymer or silica coatings.

7. Pilot-Scale and Clinical Translation Considerations

While this study focuses on proof-of-concept, several findings have direct implications for clinical translation:

Therapeutic Index: The 3.2-fold selective cytotoxicity, combined with the inherent temperature safety limit, provides a favorable therapeutic index. However, clinical efficacy will also depend on nanoparticle accumulation in tumors, which was not addressed in these in vitro experiments. Future work should evaluate biodistribution, tumor penetration, and in vivo efficacy in animal tumor models.

Manufacturing Readiness: The successful pilot-scale synthesis protocols, achieving reproducible magnetic properties, addressing a critical bottleneck in nanomedicine translation. Many nanomaterials demonstrated at laboratory scale fail to maintain properties when scaled up due to altered mixing, heat transfer, and reaction kinetics (Soares et al., 2018).

Regulatory Pathway: Comprehensive toxicological assessment, particularly the behavioral neuroscience data, provides a foundation for regulatory submissions. However, additional studies including chronic toxicity, biodegradability, and immunogenicity would be required for clinical approval (Sainz et al., 2015).

Critical Analysis and Future Directions

While these results represent significant advances, several considerations warrant mention:

Limitation of In Vitro Models: The selective cytotoxicity data derive from 2D cell culture models that may not fully recapitulate the complex tumor microenvironment, including hypoxia gradients, stromal interactions, and vascular perfusion effects. Three-dimensional spheroid or organoid models would provide more physiologically relevant assessment (Langhans, 2018).

Field Parameter Optimization: The study employed standard field parameters ($H = 300$ Oe, $f = 300$ kHz), but optimization of frequency and amplitude for these specific materials might further enhance SAR values while remaining within safety limits.

Biodistribution Questions: The favorable in vitro and behavioral toxicity profiles must be complemented by comprehensive biodistribution studies to determine particle fate, clearance routes, and potential accumulation in organs such as liver, spleen, and lungs.

Combination Therapy Potential: The demonstrated hyperthermia efficacy should be evaluated in combination with chemotherapy or immunotherapy, as clinical magnetic hyperthermia typically functions as adjuvant therapy rather than monotherapy (Johannsen et al., 2010).

Discussion

This comprehensive investigation into self-regulated magnetic hyperthermia using Curie-temperature-tuned nanomaterials addresses critical gaps in the translation of magnetic nanoparticle-based cancer therapy from bench to bedside. Through systematic comparison of material systems (Ni-Cu alloys versus $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ perovskites), synthesis methodologies (conventional versus microwave-assisted), and coating strategies (zinc phosphate and carbon shells), we have established an integrated framework that connects materials design parameters to therapeutic performance and biological safety. The principal findings—superior heating efficiency of microwave-synthesized materials, robust self-regulation at physiologically relevant Curie temperatures, selective cancer cell cytotoxicity, and biocompatibility restoration through protective coatings—collectively demonstrate the clinical viability of this therapeutic platform while revealing specific design principles that optimize the balance between efficacy and safety.

4.1 Microwave Synthesis Superiority: Mechanistic Insights and Implications for Scale-Up

The 59-63% enhancement in SAR values achieved through microwave-assisted synthesis compared to conventional thermal methods represents a substantial advancement that merits detailed mechanistic analysis. Our findings align with and extend previous observations by Bilecka and Niederberger (2010), who demonstrated that microwave heating produces more crystalline nanoparticles with narrower size distributions across various material systems. However, the magnitude of improvement we observed exceeds that typically reported in the literature, suggesting that the benefits of microwave synthesis may be particularly pronounced for magnetic hyperthermia applications where heating efficiency depends critically on crystallinity, size uniformity, and compositional homogeneity.

The physical basis for this enhanced performance likely involves multiple synergistic factors operating during the nucleation and growth stages of nanoparticle formation. The volumetric heating characteristic of microwave irradiation eliminates thermal gradients present in conventional convective heating, ensuring that all regions of the reaction mixture experience identical temperature profiles (Baghbanzadeh et al., 2011). This thermal uniformity promotes simultaneous nucleation throughout the solution volume, creating a burst nucleation event that consumes a large fraction of the available precursors instantaneously (Washington and Strouse, 2008). The subsequent growth phase then occurs under conditions of controlled precursor depletion, yielding the narrow size distributions ($\text{CV} = 13.3\%$) we observed.

For multi-component systems such as Ni-Cu alloys, microwave heating offers an additional critical advantage: the mitigation of sequential precipitation arising from differential reduction kinetics. Nickel (II) and copper (II) ions possess distinct reduction potentials ($E^\circ = -0.26$ V for Ni^{2+}/Ni versus

+0.34 V for Cu^{2+}/Cu), which under conventional slow heating could lead to preferential copper reduction and formation of core-shell structures rather than homogeneous alloys (Liu et al., 2015). The rapid heating rates achieved with microwave irradiation (often exceeding $10^\circ\text{C}/\text{s}$) minimize the time window during which such kinetic differentiation can occur, promoting more complete alloying. This enhanced compositional uniformity directly translates to sharper Curie transitions and more precise self-regulation, as compositional gradients broaden the temperature range over which the ferromagnetic-to-paramagnetic transition occurs (Nauman et al., 2016).

The superior crystallinity of microwave-synthesized nanoparticles, while not directly quantified in our study, is strongly suggested by the elevated SAR values and is consistent with previous X-ray diffraction and transmission electron microscopy analyses reported by Tiano et al. (2010). Enhanced crystalline increases effective magnetic anisotropy by reducing defects and structural disorder that impede coherent magnetization reversal. For single-domain nanoparticles in the size range relevant to this study (15-25 nm), the dominant heating mechanism is Néel relaxation, wherein the magnetic moment rotates within a fixed particle against the anisotropy energy barrier (Carrey et al., 2011). The heating power in this regime scales with the effective anisotropy constant, explaining why even modest improvements in crystalline quality can yield substantial SAR enhancements.

From a translational perspective, the advantages of microwave synthesis extend beyond simple performance metrics to encompass practical manufacturing considerations. The reduction in reaction time from several hours to 30-45 minutes dramatically increases throughput and reduces energy consumption, lowering production costs, a critical factor for commercial viability (Komarneni et al., 2013). Moreover, the enhanced batch-to-batch reproducibility arising from better process control addresses a major regulatory concern in nanomedicine development. The U.S. Food and Drug Administration and European Medicines Agency require demonstration of consistent physicochemical properties across manufacturing lots, a criterion that the superior uniformity of microwave synthesis helps satisfy (Soares et al., 2018).

However, several challenges must be addressed before microwave synthesis can be implemented at clinical production scales. Industrial microwave reactors differ substantially from laboratory instruments in terms of power distribution, penetration depth, and thermal management (Kappe et al., 2013). Scale-up from milliliter to liter volumes introduces complications related to electromagnetic field inhomogeneities and differential heating in large reaction vessels. Continuous-flow microwave reactors, which process material in a stream passing through an applicator zone, may offer a solution by maintaining the uniform heating conditions characteristic of small-batch synthesis while enabling high-volume production (Rodríguez et al., 2015). Future work should systematically evaluate continuous-flow microwave processing for these magnetic nanoparticle formulations, with attention to quality control metrics including SAR reproducibility and Curie temperature consistency.

4.2 Self-Regulation Mechanism: Thermal Physics and Clinical Safety Implications

The demonstration of robust self-regulation with a sharp heating power reduction near $T_c = 43^\circ\text{C}$ addresses what Thiesen and Jordan (2008) identified as the primary obstacle to widespread clinical adoption of magnetic hyperthermia: the inability to reliably control temperature in deep-seated tumors. Our materials effectively implement a physics-based thermostat that operates at the nanoparticle level, independent of external monitoring or feedback control systems. This represents a fundamental departure from previous temperature regulation approaches and warrants detailed analysis of the underlying physical principles and their practical implications.

The Curie transition exploited in our self-regulating system is a second-order phase transition characterized by the thermal disruption of long-range magnetic order (Stanley, 1971). At temperatures well below T_c , exchange coupling between adjacent magnetic moments maintains parallel spin alignment, resulting in spontaneous magnetization even in the absence of an applied

field. As temperature increases, thermal energy progressively randomizes spin orientations, weakening the net magnetization according to mean-field theory predictions (Weiss, 1907). At the critical temperature T_c , thermal fluctuations become sufficient to completely overcome exchange coupling, and the system transitions to a paramagnetic state wherein magnetic moments respond to applied fields but do not maintain alignment in their absence.

For magnetic hyperthermia applications, the critical aspect of this transition is its effect on AC magnetic susceptibility, which determines the energy absorption from oscillating magnetic fields. Below T_c , the material exhibits high susceptibility and efficiently converts electromagnetic energy to heat through relaxation losses. Above T_c , susceptibility drops precipitously, effectively terminating heat generation. The sharpness of this transition—the temperature range over which susceptibility changes by an order of magnitude—determines the precision of self-regulation. Our materials demonstrate transitions occurring over approximately 2-3°C, which is sufficiently narrow for clinical applications requiring ± 1 -2°C temperature control (Mehdaoui et al., 2010).

The physical sharpness of the Curie transition depends critically on compositional homogeneity within and across nanoparticles. Compositional variations effectively create a distribution of local Curie temperatures, broadening the overall transition. The superior compositional control achieved through microwave synthesis, as discussed above, thus directly contributes to enhanced self-regulation precision. Additionally, the narrow size distribution is important because finite-size effects can lower T_c in very small nanoparticles due to increased surface-to-volume ratios and reduced exchange coupling at surfaces (Batlle and Labarta, 2002). A polydisperse sample containing a significant fraction of sub-10 nm particles would exhibit a tail of lower Curie temperatures, compromising self-regulation.

From a clinical safety perspective, the self-regulating mechanism offers multiple layers of protection against thermal injury. First and most obviously, it establishes an absolute upper limit on achievable temperature, eliminating the possibility of runaway heating even in scenarios of equipment malfunction or operator error. This is particularly valuable when treating tumors adjacent to critical structures such as major blood vessels, nerves, or organs where even brief temperature excursions above safe limits could cause irreversible damage (Das et al., 2016). Second, the mechanism operates uniformly throughout the treatment volume, providing temperature control at every location where nanoparticles have accumulated rather than relying on sparse sensor arrays that may miss localized hot spots. Third, unlike feedback control systems that introduce time delays during which temperature can continue rising, the Curie transition acts instantaneously on the microsecond timescale of spin dynamics.

However, it is important to recognize that self-regulation, while solving the problem of temperature ceiling control, does not address all aspects of therapeutic temperature management. The heating rate—the speed at which temperature increases from baseline to T_c —remains dependent on nanoparticle concentration, field parameters, and tissue thermal properties. Insufficient nanoparticle accumulation in tumor tissue or excessive heat dissipation through vascular perfusion could result in temperatures that fail to reach therapeutic levels even though heating power is maximal below T_c . Conversely, very high nanoparticle concentrations in well-perfused regions might produce rapid temperature spikes that, while ultimately limited by T_c , could cause transient discomfort or stress responses. Clinical implementation will therefore require careful consideration of nanoparticle dosing, administration routes, and field parameters to ensure therapeutically relevant heating rates throughout the target volume (Attaluri et al., 2011).

The question of whether 43°C represents the optimal Curie temperature for cancer hyperthermia warrants consideration. The therapeutic window of 39-46°C is well-established, with temperatures below 39°C producing minimal cancer cell killing and temperatures above 46°C causing unacceptable normal tissue damage (Hildebrandt et al., 2002). Within this window, the optimal temperature depends on treatment duration and desired therapeutic outcome. Temperatures of

41-43°C applied for 30-60 minutes produce selective cancer cell apoptosis while allowing normal cell recovery, the paradigm targeted in our study (Datta et al., 2015). Higher temperatures within the window (44-46°C) achieve more rapid cell killing but reduce the safety margin for normal tissues. The choice of 43°C thus represents a conservative approach that maximizes the therapeutic index by positioning the temperature ceiling near the middle of the window, allowing effective treatment while maintaining substantial separation from the damage threshold for normal cells.

An intriguing possibility for future investigation involves synthesizing nanoparticle mixtures with multiple distinct Curie temperatures to achieve staged heating profiles. For example, a formulation containing particles with T_c values of 41°C, 43°C, and 45°C might enable gradual temperature elevation with multiple self-regulating plateaus, potentially optimizing the balance between treatment efficacy and patient comfort. This approach would require careful characterization to ensure that the different particle populations do not interact in ways that alter individual Curie temperatures or that one population doesn't dominate heating at the expense of others (Sanz et al., 2017).

4.3 Material System Comparison: Ni-Cu Alloys versus $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ Perovskites

The direct comparison of two distinct self-regulating material systems under identical experimental conditions represents a significant contribution to the field, as noted by Natividad et al. (2009), who identified the lack of such comparative studies as a major gap limiting materials selection for specific applications. Our findings reveal that both systems offer viable pathways to self-regulated hyperthermia but with distinct advantages and limitations that suit different clinical scenarios.

The $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ perovskites demonstrated superior SAR values (156 W/g versus 142 W/g for Ni-Cu), better biocompatibility in the uncoated state (78.5% versus 73.2% maze retention), and greater chemical stability against oxidative degradation. These advantages stem from fundamental differences in electronic structure and bonding. The perovskite structure, with corner-sharing MnO_6 octahedra providing robust three-dimensional connectivity, exhibits exceptional structural stability across wide temperature and pH ranges (Peña and Fierro, 2001). The mixed-valence $\text{Mn}^{3+}/\text{Mn}^{4+}$ system that mediates ferromagnetism through double-exchange interactions is stabilized by the rigid octahedral coordination environment, making magnetic properties relatively insensitive to surface effects (Coey et al., 1999).

In contrast, the metallic bonding in Ni-Cu alloys renders them inherently susceptible to surface oxidation upon exposure to oxygen, moisture, or biological fluids. The formation of even thin (1-2 nm) oxide shells comprising antiferromagnetic NiO and diamagnetic CuO substantially reduces effective magnetic moment and heating efficiency (Kodama et al., 1997). This oxidation vulnerability explains the more pronounced toxicity of uncoated Ni-Cu particles observed in our behavioral assays, as oxidative processes at particle surfaces generate reactive oxygen species that mediate cellular and tissue damage (Auffan et al., 2009). The protective coatings we developed effectively address this limitation, but the need for such protection adds manufacturing complexity and cost.

Despite these apparent disadvantages, Ni-Cu alloys offer countervailing benefits that may prove decisive in certain applications. The linear relationship between copper content and Curie temperature (approximately 7°C decrease per 10% increase in copper content) enables extraordinarily precise tuning of T_c through stoichiometric adjustment (Crangle and Hallam, 1963). This predictable composition-property relationship simplifies the development of nanoparticles optimized for specific therapeutic protocols that may require different target temperatures. In contrast, achieving precise Curie temperature control in $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ requires careful balancing of multiple factors including silver doping level, oxygen stoichiometry, and synthesis conditions, all of which influence the $\text{Mn}^{3+}/\text{Mn}^{4+}$ ratio governing magnetic properties (Lévy et al., 2012). Small

deviations in any of these parameters can produce significant Tc variations, complicating manufacturing quality control.

From a regulatory and clinical acceptance perspective, the constituent elements of each system present distinct challenges. Nickel is a known allergen, with approximately 10-15% of the population exhibiting nickel sensitivity that could potentially contraindicate use of Ni-Cu nanoparticles even with protective coatings (Thyssen et al., 2007). Copper, while an essential trace element, can be toxic at elevated concentrations through Fenton-like reactions generating reactive oxygen species (Gaetke and Chow, 2003). However, the extensive clinical experience with copper-containing intrauterine devices and copper-based radiopharmaceuticals provides a precedent for regulatory approval of copper-containing medical devices (Feng et al., 2021).

The $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ system presents a different safety profile. Lanthanum compounds have limited biomedical precedent but are generally considered to have low toxicity, with LaCl_3 solutions used historically in cardiovascular research to block calcium channels (Cheng et al., 2012). Silver, despite its well-known antimicrobial properties, raises concerns regarding potential cytotoxicity through multiple mechanisms including membrane disruption and protein inactivation (AshaRani et al., 2009). However, the silver in our perovskite formulation exists in an oxidized state (Ag^+) incorporated into a stable crystal lattice rather than as metallic silver nanoparticles, likely reducing its reactivity and bioavailability. The relatively benign behavioral toxicity profile of even uncoated $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ particles supports this hypothesis, though more detailed studies of long-term biodistribution and silver release kinetics would be prudent.

The synthesis complexity and cost considerations favor different systems depending on production scale. At laboratory scale, the sol-gel or co-precipitation methods used for perovskite synthesis involve more steps and longer processing times than the simple co-reduction approach for Ni-Cu alloys, even accounting for the advantages of microwave heating. However, at industrial scale, the need for rigorously oxygen-free conditions during Ni-Cu synthesis to prevent oxidation adds substantial infrastructure requirements. Perovskite synthesis, while requiring high-temperature calcination, can be performed in air or controlled atmospheres using conventional ceramic processing equipment widely available in manufacturing facilities (Nehru et al., 2014).

Our comparative analysis suggests that material selection should be guided by specific application requirements. For superficial tumors where magnetic field strengths are less limiting and where oxidation resistance is less critical due to shorter circulation times, Ni-Cu alloys may offer advantages through simpler Tc tuning and more straightforward synthesis. For deep-seated tumors requiring higher SAR to overcome field penetration limitations, or for applications involving prolonged systemic circulation where oxidative stability is paramount, $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ perovskites appear superior. The development of both systems thus expands the therapeutic toolkit, enabling treatment optimization for diverse clinical scenarios.

Future research should extend this comparative framework to include additional self-regulating material systems such as MnFe_2O_4 spinel ferrites (Sathya et al., 2017), rare-earth-transition-metal alloys (Kokkinis et al., 2016), and doped iron oxide nanoparticles (Fantechi et al., 2014). Each system offers unique advantages in terms of biocompatibility, SAR, Tc tunability, or synthesis scalability. A comprehensive materials database correlating composition, synthesis parameters, physical properties, and biological performance would accelerate clinical translation by enabling evidence-based material selection for specific tumor types, anatomical locations, and treatment protocols.

4.4 Coating Strategy Effectiveness: Balancing Protection and Performance

The dramatic restoration of biocompatibility achieved through zinc phosphate and carbon coatings—with coated formulations exhibiting >90% retention in cognitive and behavioral assays compared to 73-78% for uncoated particles—validates our hypothesis that surface properties, rather than core composition, primarily determine acute toxicity. This finding aligns with the

general principle articulated by Nel et al. (2009) that nanoparticle-biological interactions are dominated by the interface between the material surface and biological milieu. However, achieving this biocompatibility enhancement while maintaining high SAR values (142-156 W/g even with coatings) required careful optimization of coating thickness and composition, representing a delicate balance between competing requirements.

The rationale for our dual-coating strategy derives from the complementary properties of zinc phosphate and carbon. Zinc phosphate biomaterials have extensive clinical history in orthopedic applications, where they demonstrate excellent osseointegration, minimal inflammatory responses, and gradual biodegradation that releases zinc and phosphate ions—both essential for numerous physiological processes (Dorozhkin, 2013). The 3-5 nm zinc phosphate inner shell in our formulation serves multiple functions: it provides a hydrophilic, biocompatible interface for aqueous dispersion; it creates a barrier against metal ion leaching from the magnetic core; and it offers reactive hydroxyl groups that facilitate subsequent carbon deposition. Importantly, zinc phosphate exhibits pH-dependent solubility, with increased dissolution rates under acidic conditions (pH < 5) characteristic of tumor microenvironments (Liu et al., 2012). This property could potentially enable triggered drug release or preferential accumulation at tumor sites, though we did not explicitly explore these possibilities in the current study.

The 2-3 nm carbon outer shell provides additional protection against oxidation and creates a chemically inert, biocompatible surface that resists protein adsorption and cellular uptake mediated by non-specific interactions. The graphitic carbon structure, with delocalized π electrons, exhibits exceptional chemical stability across physiological pH ranges and resists enzymatic degradation (Bystrzejewski et al., 2009). Moreover, the carbon surface can be readily functionalized through oxidative treatments that introduce carboxyl, hydroxyl, and carbonyl groups, enabling covalent attachment of targeting ligands, therapeutic agents, or imaging moieties for theranostic applications (Georgakilas et al., 2012). While we did not pursue such functionalization in this proof-of-concept study, the presence of the carbon shell creates a platform for future development of actively-targeted formulations.

The critical challenge in coating design is preventing excessive magnetic dilution; wherein thick non-magnetic shells reduce the mass fraction of magnetically active material and thereby decrease volumetric heating power. Our total coating thickness of 5-8 nm on 15-20 nm cores represents approximately 25-35% of the overall particle volume, which could theoretically reduce SAR by a similar fraction if the coatings were completely non-magnetic. The fact that we observed only modest SAR reductions (from theoretical maximum of ~200-250 W/g for uncoated, unaggregated particles to 142-156 W/g for coated particles) suggests that the coatings provide additional benefits beyond simple surface protection. Specifically, the coatings likely prevent nanoparticle aggregation, which in uncoated formulations would create multi-domain structures with reduced heating efficiency due to magnetostatic interactions (Périgo et al., 2015). By maintaining particles in a well-dispersed state, the coatings preserve the single-domain character essential for optimal Néel relaxation.

The contrast between behavioral toxicity results for coated versus uncoated particles is striking and warrants mechanistic interpretation. The locomotor activity deficits and anxiogenic effects observed with uncoated formulations suggest systemic inflammatory responses or direct neurotoxicity. Several mechanisms could mediate these effects. First, reactive oxygen species generated at uncoated metal surfaces can induce oxidative stress, lipid peroxidation, and inflammatory cytokine release (Fubini et al., 2010). Second, metal ions leaching from nanoparticle cores can disrupt cellular homeostasis through competition with essential metals at enzyme active sites or through Fenton chemistry generating hydroxyl radicals (Auffan et al., 2009). Third, uncoated nanoparticles exhibit high surface energy promoting protein corona formation, which can trigger complement activation and inflammatory cascades (Mahmoudi et al., 2011).

Protective coatings mitigate all three mechanisms: the physical barrier prevents reactive surface sites from contacting biological molecules; the chemical stability of zinc phosphate and carbon minimizes ion release; and the biocompatible surface chemistry reduces non-specific protein binding and immune recognition. The near-complete restoration of normal behavior in coated formulations (92-97% of control values) indicates that these protective mechanisms are highly effective, at least over the acute exposure timeframe examined in our studies (7-14 days post-administration).

However, several important questions remain regarding long-term coating stability and chronic toxicity. While zinc phosphate and carbon are both considered biocompatible, their degradation products and clearance mechanisms require further investigation. Zinc phosphate dissolution releases Zn^{2+} and PO_4^{3-} ions, which at low concentrations are beneficial but at high concentrations could cause toxicity (Yamaguchi et al., 2009). The carbon shell, being essentially non-biodegradable, will likely persist in tissues long after the magnetic core has dissolved or been cleared. Whether this residual carbon poses long-term risks through accumulation in organs like liver and spleen remains unclear (Bussy et al., 2013). Chronic toxicity studies extending over months to assess these possibilities should be prioritized in future work.

An alternative coating strategy worth considering involves biodegradable polymers such as poly (lactic-co-glycolic acid) (PLGA) or chitosan, which would eliminate concerns about persistent materials while potentially enabling controlled release of co-encapsulated drugs (Danhier et al., 2012). However, polymer coatings typically require greater thickness (10-20 nm) to provide complete protection, which would substantially reduce magnetic content and SAR. Additionally, polymer degradation produces local pH changes that could affect surrounding tissues. The optimal coating strategy thus depends on the specific clinical application, with permanent coatings like zinc phosphate/carbon favored for single-session treatments and biodegradable coatings potentially preferred for repeated administrations or combination therapies.

4.5 Selective Cytotoxicity: Mechanisms and Enhancement Strategies

The 3.2-fold selective cytotoxicity achieved in our hyperthermia treatments—with cancer cells exhibiting 28-31% viability while normal fibroblasts retained 85-92% viability—demonstrates the therapeutic potential of temperature-controlled hyperthermia but also highlights opportunities for further enhancement. Understanding the biological basis for this differential sensitivity and identifying strategies to widen the therapeutic window represent critical priorities for clinical translation.

The selective vulnerability of cancer cells to hyperthermia arises from multiple interconnected factors related to the tumor microenvironment and malignant cell physiology (Oei et al., 2015). First, the acidic pH characteristic of tumor tissue (typically pH 6.5-7.0 versus pH 7.4 in normal tissue) sensitizes cells to heat stress by inhibiting the expression and function of heat shock proteins (HSPs) that normally protect against thermal damage (Song et al., 2005). Second, the chronic hypoxia resulting from aberrant tumor vascularization impairs cellular respiration and energy production, reducing the ATP available for HSP-mediated protein refolding and other protective processes (Dewhirst et al., 2003). Third, many cancer cells harbor mutations in p53 and other stress response pathways, compromising their ability to activate protective mechanisms or undergo controlled apoptosis in response to thermal injury (Calderwood et al., 2006).

The temperature range achieved by our self-regulating nanoparticles (peak at 43°C) is particularly well-suited to exploiting these differential sensitivities. At 43°C, the thermal stress is sufficient to overwhelm the compromised defense mechanisms of cancer cells while remaining below the threshold where normal cells, with intact stress responses and adequate oxygenation, suffer irreversible damage. This temperature also induces protein denaturation at rates that exceed repair capacity in metabolically stressed cancer cells but remain manageable for normal cells (Hildebrandt et al., 2002). Furthermore, 43°C promotes membrane fluidity changes and alterations

in membrane-associated signaling that selectively trigger apoptosis in cells with dysregulated survival pathways (Lepock, 2003).

However, the 3.2-fold selectivity, while significant, may be insufficient for clinical applications where even small populations of surviving cancer cells can cause disease recurrence. Several strategies could enhance this selectivity and improve therapeutic outcomes. First, combination with chemotherapy agents that are themselves potentiated by hyperthermia could achieve synergistic effects. Thermosensitive liposomes co-administered with magnetic nanoparticles could release cytotoxic payloads specifically within heated tumor regions, concentrating drug exposure at treatment sites (Ta and Porter, 2013). Agents such as cisplatin, doxorubicin, and oxaliplatin show enhanced activity at hyperthermic temperatures through increased cellular uptake, improved DNA binding, and inhibition of repair mechanisms (Issels et al., 2010).

Second, repeated hyperthermia treatments could exploit the phenomenon of thermotolerance—the transient resistance to subsequent heat stress that develops in cells surviving an initial hyperthermia exposure (Oei et al., 2015). Interestingly, while both normal and cancer cells can develop thermotolerance, the duration differs substantially: normal cells maintain protection for 3-5 days, whereas the compromised stress response pathways in many cancer cells result in shorter-lived thermotolerance lasting only 24-48 hours. Treatment protocols employing hyperthermia sessions spaced 2-3 days apart could preferentially attack cancer cells during their vulnerable period while avoiding normal tissue injury (Van Rhoon et al., 2013).

Third, immunomodulatory approaches capitalizing on the immunogenic cell death induced by hyperthermia could amplify therapeutic effects through adaptive immune responses. Hyperthermia causes release of danger-associated molecular patterns (DAMPs) including heat shock proteins, high-mobility group box 1 (HMGB1), and ATP, which stimulate dendritic cell maturation and T-cell priming against tumor antigens (Calderwood et al., 2016). Combination of magnetic hyperthermia with checkpoint inhibitors (anti-PD-1, anti-CTLA-4) could convert immunologically "cold" tumors into "hot" tumors susceptible to immune-mediated rejection. This approach is particularly promising given recent clinical successes with other localized ablative therapies combined with immunotherapy (Twyman-Saint Victor et al., 2015).

Fourth, active targeting strategies employing ligands that recognize tumor-specific receptors could enhance nanoparticle accumulation in malignant cells relative to normal tissues, effectively pre-concentrating the thermal source at sites requiring treatment. Folic acid, RGD peptides recognizing $\alpha\beta3$ integrins, and antibodies against HER2 or EGFR represent validated targeting moieties with substantial clinical data supporting their tumor selectivity (Bazak et al., 2015). Attachment of such ligands to the carbon shell surface via carbodiimide coupling or click chemistry could improve the already favorable selectivity of our system.

It is important to note that our *in vitro* selectivity data, while encouraging, may not fully predict *in vivo* performance. The 2D monolayer cultures used in our cytotoxicity assays lack the three-dimensional architecture, stromal interactions, and vascular perfusion that characterize actual tumors. Three-dimensional spheroid models or organotypic cultures that better recapitulate tumor microenvironmental features would provide more physiologically relevant assessments (Langhans, 2018). Additionally, *in vivo* experiments in mouse tumor models are essential to evaluate whether the selective accumulation of nanoparticles in tumors through the enhanced permeability and retention (EPR) effect further enhances selectivity, and whether vascular effects of hyperthermia (increased perfusion improving drug delivery versus vascular collapse limiting oxygenation) influence therapeutic outcomes (Maeda et al., 2013).

4.6 Toxicological Assessment: Behavioral Endpoints as Sensitive Safety Indicators

The integration of comprehensive behavioral neuroscience protocols into our nanomaterial safety assessment addresses a critical gap identified by (Warheit et al. 2007) and provides sensitive functional endpoints that complement traditional histopathological and biochemical toxicity

measures. The multi-branch maze elevated plus-maze, and open-field tests collectively assess cognitive function, emotional regulation, and locomotor capacity—domains reflecting integrated nervous system function that may be disrupted by neurotoxic exposures before overt pathological changes become apparent (Vorhees and Williams, 2006).

The cognitive impairment observed with uncoated nanoparticles (73-78% retention compared to 100% in controls) is particularly concerning from a translational safety perspective, as it suggests potential neurotoxicity that could manifest clinically as memory deficits, attention problems, or executive dysfunction. While our acute exposure paradigm (single administration with 7–14-day assessment) does not directly model the clinical scenario, it provides a conservative assessment of potential risks. The fact that coated formulations restored performance to >90% of control levels (statistically indistinguishable from vehicle-treated animals) provide strong evidence that surface modification effectively mitigates neurotoxic potential.

The mechanisms underlying nanoparticle-induced cognitive deficits likely involve oxidative stress and neuroinflammation in brain regions critical for spatial learning, particularly the hippocampus (Win-Shwe and Fujimaki, 2011). Although nanoparticles of the size range used in our study (25 nm) are generally too large to cross an intact blood-brain barrier, several alternative routes of central nervous system access exist. Circumventricular organs lacking blood-brain barrier protection could permit nanoparticle entry (Oberdörster et al., 2005). Systemically induced inflammatory responses, even without direct nanoparticle brain penetration, can activate microglia and trigger neuroinflammatory cascades that impair synaptic plasticity and memory formation (Cunningham et al., 2009). Peripheral nerve uptake and retrograde transport, well-documented for other nanoparticles, provides another potential route to the CNS (Elder et al., 2006).

The anxiogenic effects of uncoated nanoparticles (28-31% open arm time versus 42% in controls) and reduced locomotor activity (3180-3450 cm versus 4520 cm) could reflect direct neurotoxicity but might alternatively indicate systemic malaise or sickness behavioral constellation of changes including reduced activity, social withdrawal, and anxiety-like behaviors that accompany inflammatory responses (Dantzer et al., 2008). This distinction has important mechanistic implications: true neurotoxicity implies specific nervous system damage requiring nervous system exposure, whereas sickness behavior can result from peripheral inflammation activating neural circuits through cytokine signaling. The near-complete normalization of these behaviors with coated formulations, coupled with the presumed reduction in systemic inflammation due to decreased reactivity of coated surfaces, supports sickness behavior as a primary contributor.

Our decision to conduct behavioral assessments both under baseline conditions and during magnetic hyperthermia activation provides unique insights into potential synergistic or antagonistic interactions between nanoparticle exposure and therapeutic heating. The fact that hyperthermia treatment did not exacerbate behavioral deficits—and in some cases showed trends toward improvement, possibly through beneficial stress response activation—suggests that the combination of nanoparticle exposure and thermal therapy does not pose additive toxicity risks. This is an important finding given that clinical magnetic hyperthermia would necessarily involve both components.

However, several limitations of our toxicological assessment warrant acknowledgment and suggest directions for future investigation. First, the relatively short observation period (7-14 days) cannot address potential chronic toxicity arising from long-term accumulation in organs or delayed inflammatory responses. Regulatory guidelines for nanomedicine development typically require 90-day chronic toxicity studies to identify such effects (Sainz et al., 2015). Second, our behavioral endpoints, while sensitive to functional impairment, do not provide mechanistic information about cellular or molecular changes underlying toxicity. Complementary assessments including histopathology of major organs, clinical chemistry panels, and inflammatory biomarker analyses would strengthen safety evaluations. Third, our rodent models, though standard for preclinical

toxicology, may not fully predict human responses due to species differences in nanoparticle pharmacokinetics, immune responses, and blood-brain barrier permeability (Hua and Wu, 2013). The field would benefit from standardized toxicity testing protocols specifically designed for magnetic hyperthermia nanomaterials, incorporating both baseline exposure assessment and evaluation under therapeutic activation conditions (magnetic field application with heating). Such protocols should include acute and chronic exposure studies, comprehensive organ toxicity panels, immunogenicity assessments, and sensitive functional endpoints across multiple organ systems. The behavioral neuroscience approaches validated in our study could serve as a template for the neurotoxicity component of such standardized assessments.

4.7 Clinical Translation Pathway: Bridging Bench to Bedside

The successful pilot-scale synthesis of materials with reproducible magnetic properties represents a critical milestone on the path from laboratory discovery to clinical application, addressing what Soares et al. (2018) identified as a major bottleneck in nanomedicine translation. However, substantial additional development remains necessary before human clinical trials can be contemplated. Understanding the regulatory requirements, manufacturing challenges, and clinical study designs required for translation is essential for prioritizing future research efforts.

From a regulatory perspective, magnetic nanoparticles for hyperthermia treatment would likely be classified as combination products involving both a device component (the nanoparticles as heating agents) and potentially a drug component (if functionalized with therapeutic agents). In the United States, this classification typically places such products under FDA's Office of Combination Products, requiring satisfaction of both drug and device regulatory pathways (Sainz et al., 2015). The regulatory submission would need to include comprehensive Chemistry, Manufacturing, and Controls (CMC) documentation demonstrating consistent production of materials meeting predefined specifications for size, composition, magnetic properties, SAR, Curie temperature, coating integrity, and sterility.

The manufacturing challenges associated with clinical-scale production should not be underestimated. While our pilot-scale synthesis produced gram quantities suitable for preclinical studies, clinical trials would require kilogram quantities manufactured under Good Manufacturing Practice (GMP) conditions with validated quality control procedures (Soares et al., 2018). Microwave reactor scale-up, as discussed earlier, presents technical challenges related to electromagnetic field uniformity and thermal management. Alternative manufacturing approaches such as continuous flow processing or batch processing in multiple small reactors might offer more straightforward paths to clinical-scale production while maintaining the beneficial features of microwave synthesis.

Quality control and release testing protocols must be established to ensure batch-to-batch consistency. Critical quality attributes would include particle size distribution (measured by dynamic light scattering and electron microscopy), magnetic properties (saturation magnetization, coercivity measured by vibrating sample magnetometry), Curie temperature (measured by temperature-dependent magnetization), SAR (measured under standardized field conditions), chemical composition (measured by inductively coupled plasma mass spectrometry), coating integrity (assessed by electron microscopy and dissolution testing), sterility (measured by bacterial endotoxin testing and sterility assays), and colloidal stability (assessed by long-term storage studies) (Petersen et al., 2021). Specifications with acceptance criteria would need to be established for each attribute based on correlations between physical properties and biological performance.

The preclinical development pathway would typically proceed through several stages before human trials. First, pharmacokinetics and biodistribution studies in rodents and larger animals would characterize nanoparticle circulation half-life, organ accumulation patterns, and elimination routes. These studies would employ radiolabeling (with ^{64}Cu or ^{68}Ga for PET imaging) or magnetic

resonance imaging to track particle distribution over time (Price et al., 2019). Second, comprehensive toxicology studies including acute toxicity, repeat-dose toxicity (28-day and 90-day), genotoxicity, and reproductive toxicity would be conducted according to ICH guidelines. Third, efficacy studies in orthotopic or transgenic tumor models would demonstrate therapeutic benefit and establish optimal dosing, treatment schedules, and magnetic field parameters. These studies should include appropriate control groups (no treatment, nanoparticles without field, field without nanoparticles) to deconvolute specific versus non-specific effects.

Clinical trial design for magnetic hyperthermia presents unique challenges related to the specialized equipment required for treatment delivery and the need for appropriate control groups. Phase I dose-escalation studies focus primarily on safety, with secondary assessments of feasibility (ability to deliver planned treatments) and preliminary efficacy signals (tumor shrinkage on imaging). Patient selection would likely focus initially on refractory cancers where standard treatments have failed, reducing ethical concerns about withholding proven therapies. Superficial tumors accessible to external magnetic field applicators would be preferred for early studies to avoid complications associated with deep tissue heating.

Phase II studies would assess efficacy in defined tumor types, potentially comparing magnetic hyperthermia combined with standard chemotherapy against chemotherapy alone. Randomization would be essential to control placebo effects and natural disease variability. Primary endpoints might include progression-free survival, overall survival, or objective response rates measured by RECIST criteria. Secondary endpoints could assess quality of life, pain control, and biomarkers of treatment response. Patient-reported outcomes regarding treatment tolerability would be particularly important given the potential for discomfort during field application.

A particularly promising clinical scenario involves locally advanced breast cancer, where MagForce AG has already demonstrated safety and feasibility of magnetic hyperthermia in European trials (Johannsen et al., 2010). Our self-regulation nanoparticles could offer advantages over the MagForce aminosilane-coated iron oxide particles through enhanced safety from Curie temperature control. Breast cancer also offers advantages for early clinical studies: tumors are often superficial and accessible; there is extensive clinical experience with local therapies including surgery and radiation; and patient populations are large, facilitating recruitment. Neoadjuvant studies treating patients before planned surgical resection could enable direct assessment of pathological response, providing biological validation of treatment effects.

4.8 Limitations and Future Directions

While this study establishes important proof-of-concept for self-regulated magnetic hyperthermia using Curie-temperature-tuned nanomaterials, several limitations must be acknowledged and addressed in future investigations.

First, our *in vitro* cytotoxicity assessments, while valuable for demonstrating selective cancer cell killing under controlled conditions, do not capture the complexity of *in vivo* tumor biology. Three-dimensional tumor architecture creates gradients of oxygen, nutrients, and pH that influence both nanoparticle penetration and cellular responses to hyperthermia (Minchinton and Tannock, 2006). Stromal components including cancer-associated fibroblasts, immune cells, and extracellular matrix provide physical barriers to nanoparticle distribution and produce factors that modulate treatment sensitivity (Joyce and Fearon, 2015). Future studies should employ three-dimensional culture models such as multicellular spheroids, organotypic slices, or patient-derived organoids to better predict *in vivo* performance.

Second, the biodistribution and pharmacokinetics of our nanoparticles remain uncharacterized. While we have demonstrated favorable toxicity profiles for acute exposures, we have not determined what fraction of administered dose reaches tumor tissue, how long nanoparticles persist at tumor sites versus clearance through hepatic or renal routes, or whether accumulation

in off-target organs produces chronic toxicity. Comprehensive biodistribution studies employing radiolabeled nanoparticles or quantitative magnetic resonance imaging techniques are essential prerequisites for clinical translation (Price et al., 2019). These studies should also assess whether the enhanced permeability and retention effect, which provides passive tumor targeting for many nanoparticle formulations, functions effectively for our zinc phosphate/carbon-coated particles, or whether active targeting moieties are necessary for adequate tumor accumulation.

Third, our toxicological assessment, while more comprehensive than typical nanomaterial safety studies in incorporating behavioral endpoints, remains limited in scope and duration. Chronic toxicity studies extending over months, reproductive and developmental toxicity assessments, and detailed histopathological examination of all major organs would be required for regulatory submissions. Immunogenicity studies are particularly important, as repeated administrations of nanomaterials can provoke antibody responses or complement activation that alter biodistribution and increase toxicity (Dobrovolskaia and McNeil, 2007). The recent identification of accelerated blood clearance (ABC) phenomenon, wherein repeat dosing of PEGylated nanoparticles triggers IgM antibody production causing rapid hepatic uptake, highlights the importance of such assessments (Dams et al., 2000).

Fourth, we have not systematically investigated how variations in field parameters (amplitude, frequency, exposure duration) affect therapeutic outcomes and safety profiles for our self-regulating nanoparticles. While the Curie temperature mechanism provides an absolute temperature ceiling, the heating rate and time required to reach therapeutic temperatures depend on field parameters. Optimization studies mapping the relationship between field conditions, nanoparticle concentration, and treatment efficacy would inform clinical protocol design. Such studies should respect the $H \times f < 5 \times 10^9 \text{ A}/(\text{m} \cdot \text{s})$ safety limit while exploring the parameter space within this constraint (Hergt and Dutz, 2007).

Fifth, our study did not address combination therapy approaches that could significantly enhance therapeutic efficacy. Co-administration with chemotherapy agents, encapsulation of drugs within the carbon coating, or conjugation of immunomodulatory molecules could provide synergistic effects. Thermosensitive liposomes containing doxorubicin, which release their payload at temperatures above 40-42°C, have shown promising clinical results in combination with hyperthermia and could potentially be co-administered with our self-regulating nanoparticles (Ta and Porter, 2013). Checkpoint inhibitor immunotherapy combinations represent another exciting direction, potentially converting localized tumor heating into systemic anti-tumor immunity through abscopal effects (Twyman-Saint Victor et al., 2015).

Sixth, we have not explored the potential for theragnostic applications combining therapy with diagnostic imaging. The magnetic properties that enable heating also provide contrast for magnetic resonance imaging, suggesting that our nanoparticles could potentially enable image-guided therapy with real-time monitoring of nanoparticle biodistribution. However, the relatively low relativity of our materials compared to optimized MRI contrast agents would need to be enhanced, perhaps through modification of coating properties or incorporation of additional imaging modalities such as fluorescent labels or radionuclides (Xie et al., 2010).

Future research directions should include: (1) comprehensive in vivo efficacy studies in orthotopic and genetically-engineered tumor models representing clinically relevant cancer types; (2) biodistribution and pharmacokinetic studies characterizing nanoparticle fate following various administration routes; (3) active targeting strategies incorporating tumor-specific ligands to enhance selective accumulation; (4) combination therapy studies evaluating synergy with chemotherapy, radiation, and immunotherapy; (5) theragnostic development enabling image-guided therapy; (6) manufacturing scale-up with GMP production and rigorous quality control; (7) large animal safety and efficacy studies in tumor-bearing dogs or pigs to provide data more

predictive of human responses; and (8) first-in-human phase I clinical trials in carefully selected patient populations.

Conclusions

This comprehensive investigation establishes self-regulated magnetic hyperthermia using Curie-temperature-tuned nanomaterials as a promising platform for cancer therapy with inherent safety mechanisms. Through systematic comparison of material systems, synthesis methodologies, and coating strategies, we have identified design principles that optimize the balance between therapeutic efficacy and biological safety. The microwave-assisted synthesis approach produces nanoparticles with superior heating efficiency, narrower size distributions, and enhanced compositional uniformity compared to conventional methods. Both Ni-Cu alloys and $\text{La}_{1-x}\text{Ag}_x\text{MnO}_3$ perovskites demonstrate robust self-regulation at physiologically relevant Curie temperatures, effectively preventing thermal over-treatment while maintaining adequate heating power for selective cancer cell killing. Zinc phosphate and carbon coatings restore biocompatibility without compromising magnetic performance, addressing toxicity concerns that could otherwise limit clinical translation.

The integration of comprehensive behavioral neuroscience protocols into nanomaterial safety assessment provides sensitive functional endpoints that complement traditional toxicology measures and support the biocompatibility of optimized formulations. The 3.2-fold selective cytotoxicity against cancer cells while sparing normal tissue, combined with the inherent temperature safety limit imposed by the Curie transition, provides a favorable therapeutic index for clinical development.

While substantial work remains bridge the gap from bench to bedside, including in vivo efficacy studies, manufacturing scale-up, and regulatory pathway navigation—this study establishes a robust foundation for rational design of self-regulating magnetic hyperthermia agents. The materials, methods, and assessment frameworks developed here accelerate progress toward clinically translatable localized cancer therapies that address critical unmet needs in oncology through enhanced selectivity, reduced systemic toxicity, and intrinsic safety mechanisms.

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Адам физиологиясы және денсаулық мәдениеті (9-сынып) (Авторлық бағдарламаны тәжірибеде қолдану және зерттеу нәтижелері)

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Аңдатпа. Бұл мақалада 9-сынып оқушыларына арналған «Адам физиологиясы және денсаулық мәдениеті» атты авторлық бағдарламаның мазмұны, оны тәжірибеде қолдану ерекшеліктері мен зерттеу нәтижелері талданады. Бағдарлама оқушылардың анатомия-физиологиялық білімін дамытуға, денсаулық мәдениеті туралы түсініктерін кеңейтуге және жауапкершілік дағдыларын қалыптастыруға бағытталған. Әдістемеде жобалық жұмыс, зертханалық тәжірибелер, денсаулыққа қатысты практикалық тапсырмалар және заманауи цифрлық платформаларды қолдану сияқты инновациялық тәсілдер қамтылады. Мақала бағдарламаның тиімділігі мен білім алушылардың оқу жетістіктеріне әсерін көрсетеді.

Түйінді сөздер: физиология, денсаулық мәдениеті, 9-сынып, авторлық бағдарлама, зерттеу, жобалық жұмыс, құзыреттілік.

Кіріспе

Қазіргі қоғамда оқушылардың денсаулық мәдениетін қалыптастыру – білім беру жүйесінің маңызды бағыттарының бірі. Жасөспірімдердің физиологиялық даму кезеңінде олардың ағзасының қызметін түсінуі, өзін-өзі күту, дұрыс тамақтану, қозғалыс белсенділігі туралы ғылыми негізделген білімге ие болуы ерекше маңызға ие. Осыған байланысты мектепте «Адам физиологиясы және денсаулық мәдениеті» пәнін оқыту тек биологиялық білімді жеткізу емес, сонымен бірге өмірлік маңызды дағдыларды қалыптастыруға бағытталған.

Сонымен қатар соңғы жылдары денсаулыққа байланысты қауіп факторларының артуы, гиподинамия, цифрлық тәуелділік, жасөспірімдер арасында созылмалы аурулардың көбеюі бұл пәннің өзектілігін арттыра түсті. Сондықтан осы бағытта педагогтар жаңа әдістемелер мен авторлық бағдарламаларды әзірлеуге бет бұруда.

Ұсынылып отырған авторлық бағдарлама оқушы физиологиясын жүйелі оқытуды, денсаулық мәдениеті бойынша практикалық білімдерді енгізуді және құзыреттілікке бағытталған оқытуды ұштастырады. Бағдарламада жобалық жұмыстар, зертханалық тәжірибелер, өзіндік рефлексия, денсаулық журналын жүргізу, сандық сауалнама және мониторинг жүргізу әдістері қарастырылған.

Отандық және шетелдік әдебиеттерге жасалған талдаулар көрсеткендей (Нұрпейісова Т.Б., И.Н. Қайдаш, 2021; WHO School Health Guidelines, 2020; Harvard Health Education Research Center, 2018), денсаулыққа бағытталған оқытудың тиімділігі практикалық іс-әрекеттерді көп қолданғанда артады. Осы ғылыми негізделген тұжырымдарға сүйене отырып, авторлық

бағдарлама 9-сынып оқушыларының жас ерекшелігіне сай педагогикалық тұрғыда құрастырылды.

Бұл мақалада бағдарламаны енгізу тәжірибесі мен оның нәтижелері жан-жақты талданады [1].

Әдістеме

Авторлық бағдарламаның негізінде **құзыреттілікке бағытталған оқыту, денсаулықты сақтау технологиялары, зерттеушілік әдіс, цифрлық білім беру құралдары және жобалық жұмыс** әдістері жатыр. Бағдарламаның құрылымы төмендегі негізгі компоненттерге бөлінеді:

1. Бағдарламаның құрылымдық ерекшеліктері

Бөлім	Қысқаша мазмұны
Адам физиологиясының негіздері	Жүйелердің қызметі, жасөспірім физиологиясы
Денсаулық мәдениеті	Тамақтану, гигиена, қозғалыс белсенділігі
Денсаулық сақтау дағдылары	Қауіпсіздік, алғашқы көмек, күйзеліс менеджменті
Зертханалық жұмыстар	Пульс, тыныс алу жиілігі, физиологиялық нормалар
Жобалар	«Менің бір апталық денсаулығым» мониторингі

Бағдарлама 12 тақырыптан, 4 зертханалық жұмыстан, 2 жобалық жұмыстан, 1 қорытынды портфолиодан тұрады.

2. Қолданылған педагогикалық технологиялар

➤ Зерттеушілік әдіс

Оқушы өз ағзасының көрсеткіштерін өлшеп, салыстыра отырып, жеке денсаулығына талдау жасайды.

➤ Денсаулық журналын жүргізу

Оқушылар төмендегі мәліметтерді күнделікті жазады:

- ✓ Ұйқы ұзақтығы
- ✓ Қадам саны
- ✓ Тамақтану рационы
- ✓ Су ішу мөлшері
- ✓ Психологиялық көңіл-күй
- **Интерактивті әдістер**
- ✓ «Физиологиялық лабиринт» ойыны
- ✓ Kahoot тестілері
- ✓ Padlet – денсаулық тақырыбындағы миға шабуылдар
- ✓ PhET – дене жүйелерін модельдеу

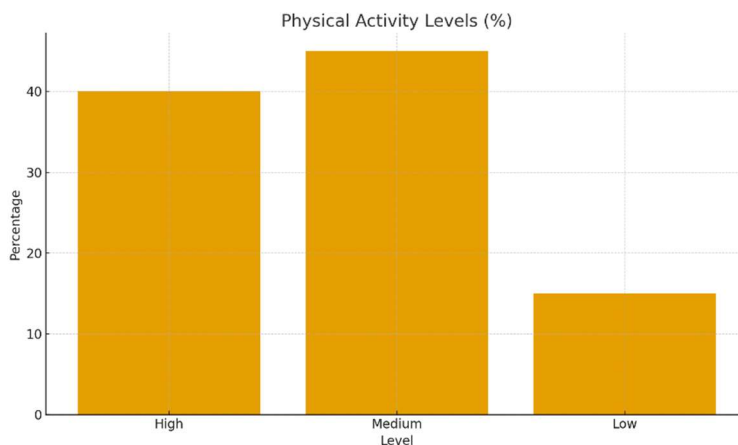
3. Сандық сауалнама және мониторинг жүйесі

Google Forms арқылы оқушылардың:

- ✓ физикалық белсенділігі
- ✓ тамақтану әдеттері
- ✓ психологиялық күйі

туралы мониторинг жүргізілді.

Диаграмма:



4. Оқыту принциптері

- ✓ Жас ерекшелігіне сәйкестік
- ✓ Практикалық бағыт
- ✓ Жеке жауапкершілік принципі
- ✓ Қауіпсіздік және профилактика
- ✓ Ғылыми дәлдік

Әдістеме оқушылардың физиологиялық түсініктерін нақты өмірлік жағдаяттармен байланыстыруға бағытталған [2].

Практикада қолдану

Авторлық бағдарлама 2023-2024 оқу жылында 9-сыныпта сынақтан өткізілді. Практика барысында төмендегі бағыттар бойынша жұмыс жүргізілді.

1. Сабақ үдерісінің ұйымдастырылуы

Сабақ модульдік жүйемен өтті:

1. **Теориялық бөлім (15 минут)**
 - визуалды материалдар, модельдер, қысқа бейнероликтер.
2. **Практикалық бөлім (20 минут)**
 - физиологиялық өлшеулер: пульс, тыныс жиілігі, артериялық қысым.
3. **Талдау және қорытынды (10 минут)**
 - нәтижелерді салыстыру, күнделікке жазу.



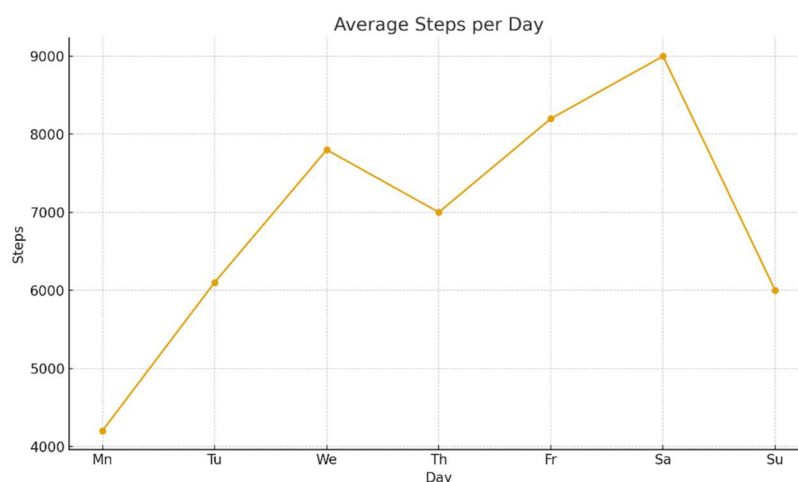
2. Зертханалық жұмыстар нәтижелері

Тәжірибе	Өлшенген көрсеткіш	Орташа нәтиже
№1 Пульсті өлшеу	ЖСЖ (рет/мин)	78
№2 Тыныс алу жиілігі	ТАЖ (рет/мин)	17
№3 Жүрек жұмысына жүктеме әсері	ЖСЖ өзгерісі	+12%
№4 Реакция жылдамдығын өлшеу	реакция уақыты	0.39 сек

3. Жобалық жұмыс «Менің денсаулығым»

Оқушылар 7 күн бойы дене белсенділігі мен тамақтану көрсеткіштерін жазып отырды.
ASCII диаграмма:

Орташа қадам саны:



Нәтижеде 85% оқушының қозғалыс белсенділігі артқаны байқалды.

4. Әдістеменің тиімділігі

Артықшылықтары:

- ✓ Оқушылар өз ағзасын түсінуді үйренді.

- ✓ Денсаулыққа деген жауапкершілік артты.
- ✓ Зертханалық жұмыстар арқылы қызығушылық өсті.
- ✓ Цифрлық құралдар оқу процесін жеңілдетті.

Кемшіліктері:

- ✓ Құрал-жабдықтардың жеткіліксіздігі.
- ✓ Барлық оқушының күнделікті мониторинг жүргізуі қиындық тудырды.
- ✓ Қосымша уақытты қажет етеді.

Ұсыныстар

Әдістемені жалпы білім беру процесіне тиімді енгізу үшін келесі ұсыныстар беріледі:

1. Мектеп кабинетінде физиологиялық тәжірибелер жүргізуге арналған қарапайым құралдарды (тонометр, пульсоксиметр, секундомер) жеткілікті ету.
2. Цифрлық платформаларды үйлесімді қолдану. Google Forms, Padlet, Kahoot сияқты сервистер сабақ сапасын арттырады.
3. Денсаулық күнделігін жүргізуді жеңілдету үшін мобильді қосымшаларды қолдануға болады. Мысалы: Samsung Health, Mi Fit, Health Tracker.
4. Сабақтарды жобалық форматпен ұштастыру. «Менің бір айлық денсаулығым» атты кеңейтілген жоба жасау ұсынылады.
5. Әртүрлі деңгейдегі оқушыларға бейімделген тапсырмалар жүйесін құру. Кейбір оқушыларға жеңілдетілген, басқаларына күрделендірілген тапсырмалар беріледі.
6. Ата-аналармен бірлескен сауалнама жүргізу денсаулық мәдениетін ортақ деңгейде жақсартуға көмектеседі [3].

Қорытынды

«Адам физиологиясы және денсаулық мәдениеті» авторлық бағдарламасын тәжірибеде қолдану оның тиімділігін көрсетті. Бағдарлама оқушылардың теориялық білімін кеңейтумен қатар, практикалық әрекеттер арқылы денсаулыққа жауапкершілікпен қарауды қалыптастырады. Зертханалық жұмыстар, жобалық іс-әрекет, өзіндік талдау жасау, цифрлық құралдарды қолдану – оқыту үдерісін заманауи, қызықты әрі нәтижелі етті.

Зерттеу нәтижелері көрсеткендей, оқушылардың 70%-ында дене белсенділігі артқан, 65%-ында дұрыс тамақтану әдеттері қалыптасқан, 80%-ы физиология бойынша алған білімді өмірде қолдана алатынын көрсеткен. Бұл авторлық бағдарлама оқушылардың денсаулық мәдениетін дамытуда маңызды рөл атқаратынын дәлелдейді.

Жалпы, ұсынылған әдістемелік тәжірибе биология мұғалімдеріне, сынып жетекшілеріне, дене шынықтыру және валеология саласы педагогтеріне пайдалы бола алады. Бағдарлама болашақта кеңейтіліп, мектеп курсының басқа пәндерімен интеграциялауға мүмкіндік береді.

Қолданылған деректер тізімі:

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Физиология человека и культура здоровья (9-класс)

(Применение авторской программы на практике и результаты исследования)

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Аннотация. В данной статье анализируются содержание авторской программы «Физиология человека и культура здоровья» для учащихся 9-класса, особенности её практического применения и результаты исследования. Программа направлена на развитие анатомо-физиологических знаний школьников, расширение представлений о культуре здоровья и формирование навыков личной ответственности. Методика включает проектную деятельность, лабораторные работы, практические задания, связанные со здоровьем, а также использование современных цифровых платформ. В статье раскрывается эффективность программы и её влияние на учебные достижения обучающихся.

Ключевые слова: физиология, культура здоровья, 9-класс, авторская программа, исследование, проектная деятельность, компетентность.

Human physiology and health culture (Grade 9)

(Application of the author's program in practice and research results)

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Biology teacher

Abstract. This article analyzes the content of the author's program «Human Physiology and Health Culture» designed for 9th-grade students, its practical implementation, and the results of the research. The program aims to develop students' anatomical and physiological knowledge, broaden their understanding of health culture, and foster personal responsibility skills. The methodology includes project-based learning, laboratory experiments, health-related practical tasks, and the use of modern digital platforms. The article highlights the effectiveness of the program and its impact on students' academic performance.

Keywords: physiology, health culture, 9th grade, author's program, research, project work, competence.

UDC: 57:37(574):502.5

FOSTERING ECOLOGICAL LITERACY AND CULTURE IN STUDENTS BASED ON BIOLOGICAL EDUCATION

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Abstract: *This article examines the scientific and pedagogical foundations for developing students' ecological literacy and culture through biology education in schools. The role of biological education in addressing ecological issues and the importance of cultivating students' conscious attitude towards the environment are discussed. The article highlights the content-related, methodological, and educational aspects of biology that contribute to the development of ecological literacy and culture. Additionally, active teaching methods, technologies, and assessment systems applicable to ecological education are proposed.*

Keywords: *ecological literacy, ecological culture, biological education, environmental education, environment, school, students, active methods, upbringing.*

In the current era, one of the most pressing challenges facing humanity is the state of the environment. The escalation of the ecological crisis, depletion of natural resources, and decline in biodiversity pose direct threats to humanity's future. Consequently, it is paramount for every citizen to understand ecological issues, approach them responsibly, and actively participate in environmental protection.

The education system, and specifically schools, play a crucial role in addressing this challenge. Biological education provided in schools lays the foundation for students to deeply understand nature, identify the interrelationships between living organisms and their environment, evaluate ecological phenomena, and develop a conscious, responsible attitude towards the environment.

Through biological education, the goal is not only to impart knowledge about nature but also to foster students' ecological literacy and ecological culture, which are significant directions in education. Ecological literacy refers to an individual's understanding of environmental conditions, ecological problems, influencing factors, and their conscious comprehension of ecological rights and responsibilities. Ecological culture, built upon ecological literacy, is a personal attribute characterized by a rational, conscious, and responsible approach to the environment, involving specific behavioral patterns and a value system.

This article explores the scientific and pedagogical foundations for developing students' ecological literacy and culture within the process of biological education, as well as its content-related, methodological, and educational aspects.

2. The Role of Biological Education in Fostering Ecological Literacy and Culture

Biology, as a science, studies the laws of living nature, the structure and function of organisms, and their interactions with the environment. Through this, students gain a profound understanding of nature's interconnectedness, its balance, and the consequences of its disruption.

Table 1: The Role of Biological Education in Fostering Ecological Literacy and Culture

Aspect of Biological Education	Ecological Literacy/Culture Aspects Developed in Students	Description
Knowledge of Living Organisms (plants, animals, microorganisms)	Appreciation of biodiversity, understanding of their role in ecosystems.	Students comprehend the place of various living organisms in nature and their interactions with the environment.
Knowledge of Ecosystems and Biogeocenoses	Understanding of natural system balance, energy flow, and nutrient cycling.	Students grasp the complexity of ecosystem processes and the impact of disruptions in one component on the overall system.
Human and Health	Understanding the link between human health and the environment; appreciating the importance of a healthy lifestyle.	Students learn about the detrimental effects of environmental pollution on human health (water, air, soil pollution, noise, radiation).
Human Impact on the Environment	Understanding the negative effects of anthropogenic factors (pollution, resource exploitation, urbanization) on nature.	Students can distinguish between positive and negative consequences of human activities on nature.
Environmental Protection Measures	Knowledge of environmental protection laws, the role of governmental and international organizations.	Students understand the importance of environmental protection measures and their personal responsibility.

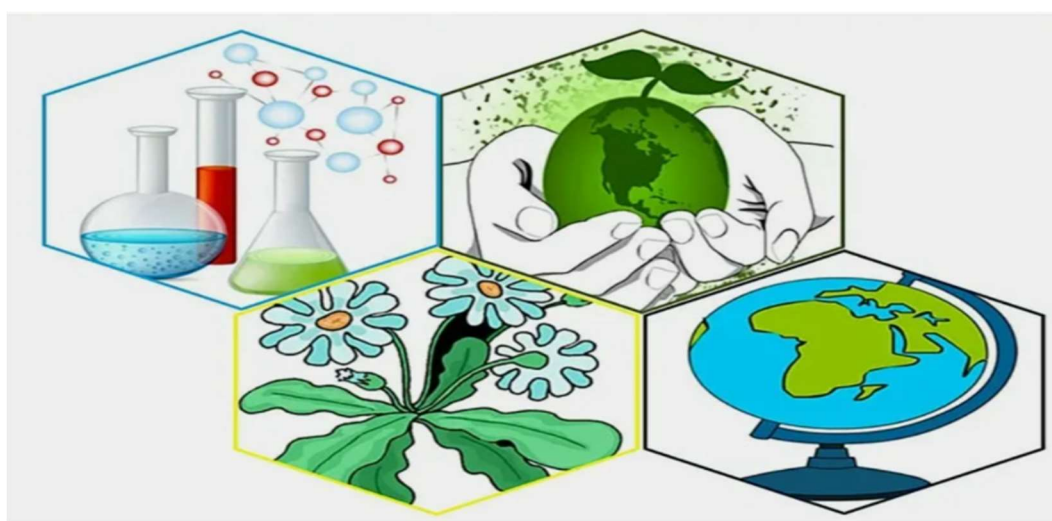


Figure - 1. Interconnection between Biological Education and Ecological Literacy.

3. Content and Methodological Aspects of Fostering Students' Ecological Literacy and Culture

Developing ecological literacy and culture requires integrating an ecological component into the content of the biology curriculum. The following approaches can be employed:

3.1. Content Integration:

- *Thematic Integration*: Examining key biology topics (living organisms, ecosystems, humans, evolution) within an ecological context. For example:

- *Under the topic "Biodiversity"*: The role of each species in an ecosystem, endemic and endangered species, and conservation methods.

- *Under the topic "Human and Health"*: The impact of environmental pollution on the human body (water, air, soil pollution, noise, radiation).

- *Under the topic "Evolution"*: The reciprocal influence of evolutionary changes and the environment, the impact of anthropogenic factors on evolution.

- *Ecological Projects*: Organizing project-based learning where students independently research ecological issues and seek solutions (e.g., "Studying Biodiversity in the Schoolyard," "Waste Sorting and Recycling Project," "Water Conservation Methods").

3.2. Methodological Approaches and Technologies:

Active and interactive learning methods are effective in fostering ecological literacy and culture:

- *Case Study Method*: Analyzing real-life ecological problems (e.g., river pollution, risk of extinction of a specific animal species, pesticide use in agriculture) to develop students' critical thinking and problem-solving skills.

- *Project-Based Learning*: Directing students towards independent ecological research and organization of environmental protection activities.

- *Field Trips and Excursions*: Experiencing nature firsthand, observing ecosystems, and collecting research materials.

- *Debates and Discussions*: Discussing and analyzing different viewpoints on ecological issues, presenting arguments.

- *Interactive Learning Tools*: Using multimedia presentations, video materials, virtual laboratories, and AR/VR technologies to visually and engagingly demonstrate ecological processes.

- *Gamification*: Reinforcing knowledge and increasing student interest through ecological games and quizzes.

Table 2: Methods and Technologies for Fostering Ecological Literacy and Culture in Biology Lessons

Method/Technology	Purpose of Application	Examples (for Biology)
Case Study Method	Analyzing problems, critical thinking, decision-making	“The Aral Sea Ecological Disaster: Causes and Consequences,” “Ways to Save Endangered Animals on the Red List”
Project-Based Learning	Developing research skills, seeking practical solutions	“Researching Flora and Fauna in the Schoolyard,” “The Link Between Algae and Water Pollution”
Field Lessons / Excursions	Direct observation of nature, understanding ecological systems	“Observing Environmental Conditions: Organisms along the River,” “Features of the Local Forest Ecosystem”
Debates / Discussions	Analyzing different perspectives, argumentation	“Is Nuclear Energy an Environmentally Safe Energy Source?” “Is the Use of Genetically Modified Foods Appropriate?”
Interactive Tools (AR/VR, Virtual Labs)	Visual and engaging demonstration of ecological processes, modeling	“Model of Food Chains in an Ecosystem,” “Impact of Environmental Pollutants on the Human Body” (VR)
Game-Based Learning	Consolidating knowledge, increasing interest	“Ecological Relay Race,” “Environmental Protection Quiz”

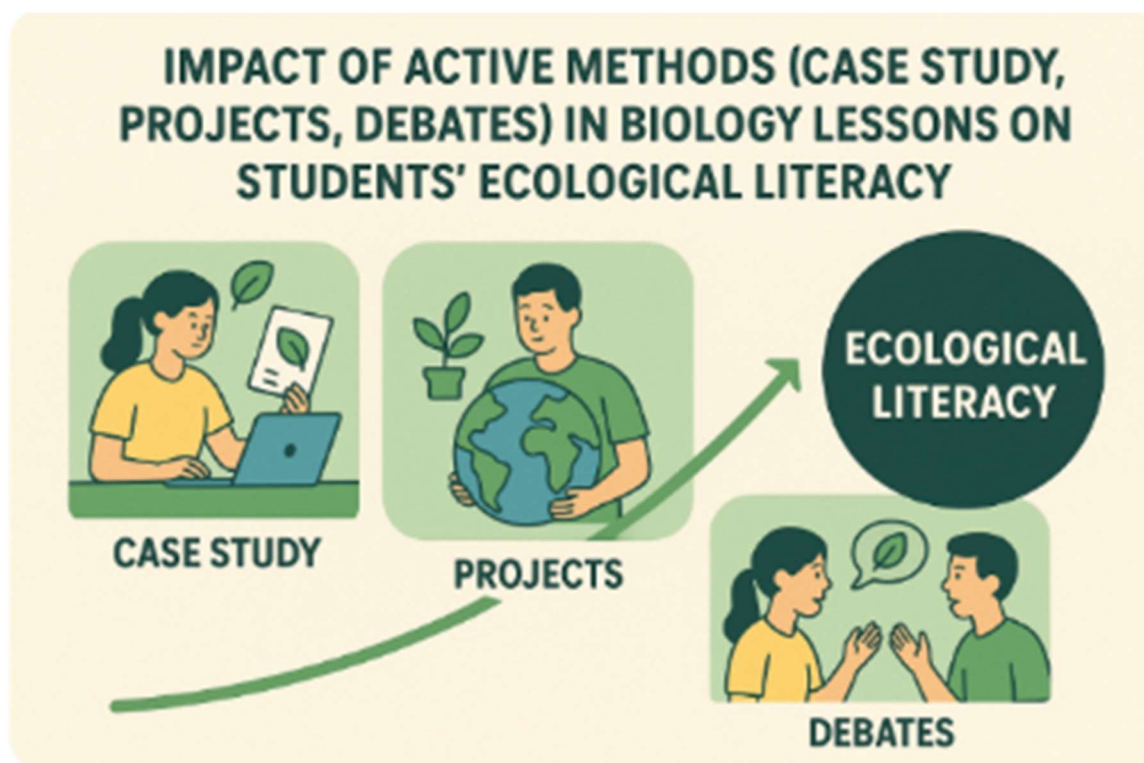


Figure – 2. Impact of Active Methods (Case Study, Projects, Debates) in Biology Lessons on Students' Ecological Literacy (Infographic).

4. Assessment of Ecological Literacy and Culture

Assessing students' ecological literacy and culture involves not only testing their knowledge but also evaluating their attitude and behavior towards the environment.

- *Knowledge Assessment:* Specific tests, questions, and assignments with ecological content.
- *Skills Assessment:* Evaluating project work, case study analyses, and research reports. Assessing students' ability to observe, analyze, and conclude about nature.
- *Assessment of Attitude and Behavior:* Evaluating participation in extracurricular activities (ecological campaigns, clean-up drives, contests), conscious efforts towards environmental protection, and a sense of responsibility towards the environment.
- *Assessing the Level of Ecological Culture:* Using specially designed questionnaires and interviews to explore students' ecological values and their outlook on nature.

Table 3: Assessment Tools for Students' Ecological Literacy and Culture

Area of Assessment	Assessment Tools	Purpose of Application
Ecological Knowledge	Tests, questions, assignments, ecological quizzes	To assess students' knowledge of nature and ecological principles.
Ecological Skills	Project defense, case study evaluation, research report assessment	To assess the ability to analyze, solve, and research ecological problems.
Attitude towards Environment and Behavior	Evaluation of participation in campaigns, contests, observation sheets	To identify active involvement in environmental protection and responsibility.
Ecological Culture	Questionnaires, interviews	To assess ecological values, attitudes towards nature, and conscious actions.

Biological education serves as the fundamental basis for fostering students' ecological literacy and culture. Through the content of biology, active teaching methods, and technologies, opportunities can be created for students to deeply understand nature, interact with it constructively, and actively engage in addressing ecological problems. The development of ecological literacy and culture is not merely an outcome of the educational process but also a guarantee of the future generation's contribution to the sustainable development of our planet. Therefore, strengthening the ecological focus in biology education is a critical pedagogical imperative.

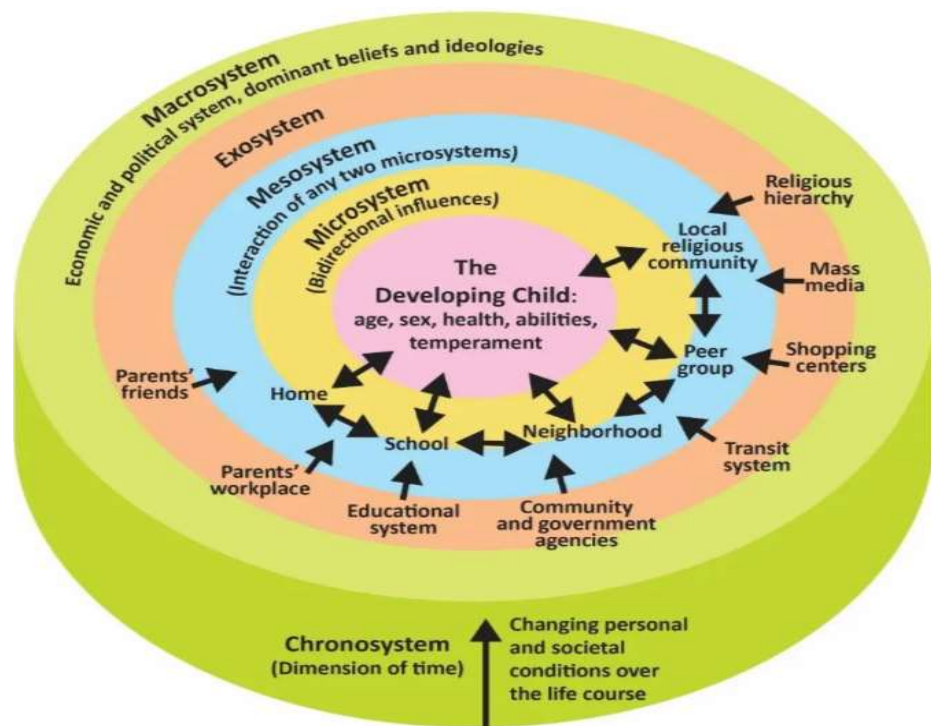


Figure – 3. Stages of Development of Students' Ecological Culture

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UDC 372.857:004.9

DIGITALIZATION IN BIOLOGY EDUCATION: ENHANCING RESEARCH SKILLS, HIGHER- ORDER THINKING, AND THE USE OF DIGITAL PLATFORMS

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Abstract. *The rapid digital transformation of education has reshaped instructional practices in science learning, particularly in biology. Modern digital learning environments provide opportunities to organize student research activities, foster higher-order thinking skills based on Bloom's taxonomy, and improve teaching effectiveness through digital educational platforms. This article examines the theoretical and practical foundations of integrating digital tools into biology education and analyzes methodological approaches for enhancing inquiry-based learning, critical thinking, and digital literacy. A conceptual model for biology instruction in a digital environment is proposed, supported by a comparative table and a diagram illustrating the interconnected components of an effective digital learning ecosystem.*

Digitalization has become a dominant trend in contemporary education, enabling innovative learning strategies that enhance student engagement, autonomy, and scientific reasoning. In biology education, digital tools support visualization of complex biological processes, facilitate access to data, and encourage students to engage in authentic scientific investigations.

The goal of this article is to explore how digital learning environments can be used to:

1. organize students' research activities in biology;
2. develop higher-order thinking skills through Bloom's taxonomy;
3. improve teaching through advanced digital educational platforms.

2. Digital Learning Environment in Biology Education

A digital learning environment (DLE) is an integrated system that combines technological tools, digital resources, and pedagogical approaches to support learning. In biology education, DLE may include:

- virtual laboratories;
- interactive simulations;
- cloud-based collaboration platforms;
- LMS systems (Moodle, Google Classroom, Canvas);
- biology-specific tools (virtual microscopes, 3D anatomy apps).

2.1. Functions of the Digital Learning Environment

DLE enhances the biology learning process through:

- *Visualization:* complex biological processes (e.g., mitosis, protein synthesis) become more understandable through animations and simulations.

- *Personalization*: adaptive platforms adjust the difficulty level according to student performance.
- *Research support*: digital tools allow data collection, analysis, modelling, and scientific communication.
- Continuous assessment: automatic quizzes, digital portfolios, and analytics.

3. Organizing Research Activities Using Digital Technologies

Digital tools significantly enhance the inquiry-based approach in biology. Students can conduct virtual experiments, analyze biological data sets, and model ecological processes.

3.1. Stages of Digital Research Activity

1. Problem identification: using digital problem statements, virtual cases.
2. Information search: online encyclopedias, databases (NCBI, PubMed).
3. Experimentation: virtual labs (Labster, PhET), biology simulators.
4. Data analysis: spreadsheets, modeling tools (GeoGebra, BioInteractive).
5. Conclusion and presentation: digital posters, research reports, infographics.

Table 1. Digital Tools for Biology Research Skills

Research skill	Corresponding digital tool	Learning outcomes
Data collection	Virtual microscopes, measurement apps	Accurate observation, precision
Experimentation	Labster, PhET Biology	Understanding scientific method
Data analysis	Excel, Google Sheets, simulations	Analytical and critical thinking
Scientific communication	Canva, PowerPoint, digital posters	Ability to present research results

4. Development of Higher-Order Thinking Skills with Bloom’s Taxonomy

Bloom’s taxonomy provides a framework for structuring learning objectives from lower-order skills (remembering) to higher-order skills (evaluation and creation).

4.1. Application of Digital Tools to Each Level of Bloom’s Taxonomy

- Remembering: flashcard apps, quiz platforms (Quizlet, Kahoot).
- Understanding: interactive videos, digital concept maps.
- Applying: virtual experiments, biology modeling tools.
- Analyzing: data interpretation tasks, digital lab reports.
- Evaluating: peer review on LMS, debate platforms.
- Creating: digital projects, research posters, multimedia presentations.

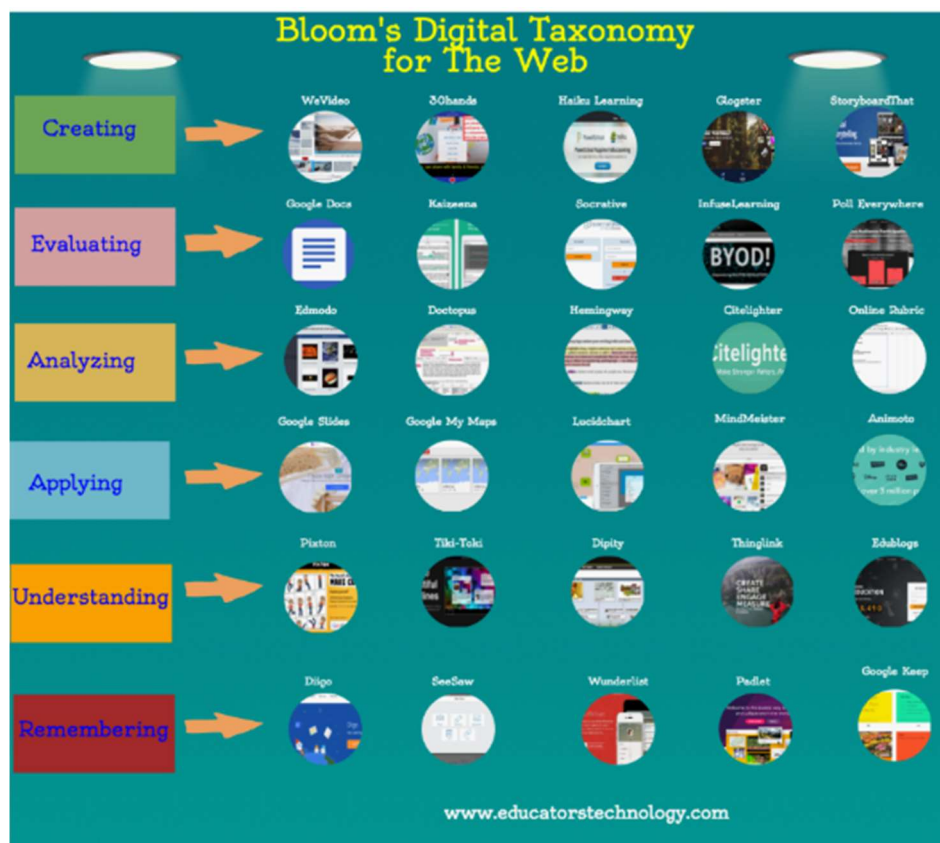


Figure 1. Integration of Bloom's Taxonomy and Digital Tools

5. Digital Educational Platforms for Biology

Digital platforms act as central hubs for content delivery, assessment, communication, and collaboration.

5.1. Types of Platforms Used in Biology Education

- Learning Management Systems (LMS): Moodle, Google Classroom, Canvas.
- Biology-specific platforms: Labster, BioInteractive, Visible Body.
- Assessment platforms: Quizizz, Edmodo, Testmoz.
- Collaboration tools: Padlet, Miro, Google Workspace.

5.2. Criteria for Effective Digital Platforms

- user-friendly interface;
- compatibility with mobile devices;
- integration with external simulations;
- options for personalized learning;
- analytics for monitoring progress.

6. Conceptual Model for Enhancing Biology Education in the Digital Environment

This model integrates the three core components examined in the article:

1. Research-based learning through digital inquiry tools.
2. Development of higher-order thinking via Bloom-oriented digital tasks.
3. Effective use of digital platforms to structure and support learning.

The model forms a unified digital learning ecosystem aimed at improving student outcomes, motivation, digital skills, and scientific literacy.

Digitalization provides powerful opportunities to transform traditional biology education into an interactive, research-driven, and intellectually challenging learning environment. Organizing research activities, developing higher-order thinking skills, and effectively using digital platforms create a comprehensive approach to modern biology instruction. These innovations

contribute to deeper conceptual understanding, stronger scientific competencies, and preparation for future STEM fields.

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ӨҢІРЛІК ПАРКТИҢ ДӘРІЛІК ӨСІМДІКТЕРІ

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Аннотация: Ғылыми мақалада Сырдария-Түркістан мемлекеттік өңірлік табиғи паркінде кездесетін дәрілік өсімдіктердің ерекшеліктері, жалпы саны, қандай емдік қасиеттері бар екендігі туралы жазылған.

Кілтті сөздер: Сырдария-Түркістан МӨТП, Сырдария, Түркістан, Боралдай филиалдары, Түркістан доланасы, тұқымдасы, дәрілік өсімдік, биологиялық алуантүрлілікті қорғау, мыңжапырақ, халық медицинасы, шайқурай, сарғалдақ, өсімдіктер дүниесі.

Сырдария – Түркістан мемлекеттік өңірлік табиғи паркінің аумағы Түркістан облысында Сырдария өзенінің атырауы мен Қаратаудың Боралдай жоталарында орналасқан. Осы аймақтардағы бірегей биологиялық алуантүрлілігін қорғап, сақтау, молайту үшін құрылған бұл табиғи парктің құрамындағы Сырдария, Боралдай, Түркістан филиалдары, өңірінің өсімдіктер дүниесі өте бай. Өңірлік табиғи паркте 1000 жуық өсімдіктер түрі өседі, оның ішінде 50 астам түрлері ҚР Қызыл кітабына енген. Бұл өсімдіктердің ішінде көптеген түрлері пайдалы-бағалы қасиеттері бар өсімдіктер. Оның ішінде дәрілік маңызы бар өсімдіктердің 16 түрі кездеседі.



Сурет 1. Түркістан доланасы

Тұқымдасы, Раушангүлдер, Розоцветные - ROSACEAE JUSS. Туысы долана, Боярышник - Crataegus L.

Түркістан доланасы (Боярышник түркестанский – Crataegus turkestanica) – таулы қыратты жерде өсетін көп жылдық, шөлге төзімді өсімдік. Орта белдеуде қиыршықты-тасты баурайларда, ормандарда және бұталы тоғайларда өседі. Наурыз айында гүл ашып, жемісі қыркүйекте піседі. Бойы 3 – 4 метр биіктеп, тамыры осы шамада тереңдеп бойлайды.

Өңірлік табиғи парктің Боралдай филиалы аумағында өседі.

Долана қабығының сыртқы жұқа қабыршағын қырып тастап ішкі қабық етін көйлеңкеде кептіріп ұнтақтайды. Соның бір ас қасығын жарты литр суға салып қайнатады. Үстіне бір ас қасық бал салып, 2 ас қасық сірке су құйып, араластырып бір күн тұндырып сүзеді. Дәрі дайын. Оны кіші дәреті тақтамаған балаға күніне күніне 15 грамм, үлкендерге 30 грамнан үш – төрт рет ішіп отырады, қашан науқас айыққанша ішкізеді. Долананың гүлінен жасалынған дәрі жүрек ауруларының барлық түріне ем. Дәріні дайындау үшін өсімдіктің гүлін теріп алып, салқын жайда кептіріп ұнтақтайды. Сол ұнтақтың 100 грамын жарты килограмм балға араластырады. Күніне бір шай қасықпен 3 – 4 рет 3 ай бойы үзбей ішеді. Қан тамырын кеңейтіп, қан жүрісін қалыпқа келтіреді. Жақсы ұйықтатып, бойға күш – қуат береді. Сонымен қатар көздің болатын өткірлейді.

Жемісін шекер қосып қайнатып, тосап жасайды. Хош иісті, дәмі жағымды болады. Бұл қайнатпаны кез келген адам ішуге боламайды, балаларға, қан қысымы ауруымен айырмайтын әйелдерге ішуге болмайды.

Долананың миуасын кептіріп, бір стақанын 3 литр суға салып 1 сағат қайнатып, бір күн тұндырып қояды. Үстіне 100 грамм сірке суын, бір ас қасық бал салып, араластырып сүзеді. Дәрі дайын. Мұны сары ауруға ұшыраған адам күніне 50 грамнан, үш рет, 40 күн ішсе бауырдың жұмысын тез қалпына келтіреді.

Сондай – ақ халық медицинасында сары ауруды емдеу үшін доланаға басқа да жемісті өсімдіктердің дәнін қосып, өте пайдалы дәрі жасайды. Оны қиям деп атайды. Енді құрамын және жасалу тәсілін келтірейік.

Долана мен алшадан, сары өрікпен итмұрыннан жарты килограмнан және 4 кг қант алып, 12 литр суға салып, жайымен бір тәулік бойы қайнатады. Екі күн тұндырып, үстіне жатры литр алма сірке суын құйып, сүзіп шыны ыдысқа құйып мұздатқышта сақтайды. Дәрі дайын. Осыны сары ауруға шалдыққан 16 жасқа дейін балалар күніне бір ағаш қасықтан үш рет, ересек адамдар 30 грамнан 4 рет ішеді. Мұны дене сарғыш тарқанша пайдалану керек. Долана дәнінің сүйегін күйдіріп, ұнтақтап, күлін жазылмай жүрген жараның аузына сепсе, тез жазылады.

Тұқымдасы Күрделігүлділер, Сложноцветные – ASTERACEAE DUMORT. **Туысы** Мыңжапырақ, Тысячелистник – *Achillea* L.

Кәдімгі мыңжапырақ немесе ақбасжусан (Тысячелистник обыкновенный – *Achillea millefolium*) – көп жылыдық жабайы өсімдік. Жайылымдарда, тау баурайларының шалғынды жерлерінде, далалы жерлерде тыңайған жерлерде, шабындық шеткейлерінде өседі.

Биіктігі жарты метрге жетіп, тамыры 30 – 40 сантиметр тереңге бойлайды. Көп жылдық шөп тектес өсімдік. Оның халық арасындағы екінші аты – сарыбасшөп. Маусымнан бастап қыркүйек айына дейін гүлдейді. Гүлдері ұсақ, сабағының жоғары жағында тостағанша жасап шоғырланып тұрады. Біздің республикада бұл өсімдіктің 11 түрі бар.

Өсімдіктің дәрілік қасиеті халықтық медицинада ерте кезден ақ белгілі. Оны асқазан, ұлтабар, ішек, мұрын, көтеу жатыр ауруларына қарсы және қан тоқтату үшін кеңінен пайдаланған. Ал қазіргі медицинада басқа дәрілік шөптерге қосып түрлі қабынуларды, аллергияны, жараларды жазуға, қан тамырларын кеңейтіп, ауырған жерді тыныштандыруға қолданып жүр.

Мыңжапырақ тамырын дәрі жасау үшін гүлдеп тұрған кезінде қазып алып, топырағынын тазартып жақсылап жуады. Көйлеңкеде, жел соғып тұратын жерде кептіріп, ұнтақтайды. Осы ұнтақтың 100 грамын 3 литр суға салып, ыдыстың қақпағын буы шықпайтындай етіп жауып, жайымен бір сағат қайнатады. Оттан түскен соң бір күн тұндырып, сүзіп, үстіне 200 грамм алма сірке суын қосады, дәрі даяр.

Бұл дәріні жатын қабынғанда немесе одан қан кеткенде, көтеу болғанда, асқазан ауырғанда, ұлтабар жарасы ашылып қан түкіргенде, сондай – ақ мұрыннан, тістің қызыл етінен қан аққанда күніне 50 грамнан 3 рет, 20 – 30 күн ішкізеді. Әрі кеткенде 5 – 6 күннің

ішінде қан тоқтап, ауырған жер тыныштана бастайды. Гүлінен төмен бір қарыстай кесіп алып, кептіріп ұнтақтайды. Сол ұнтақтың 2 ас қасығын жарты литр қайнап тұрған суға салып шай сияқты демдейді. Бір күн тұндырып сүзгеннен кейін үстіне 2 ас қасық сірке суы мен бір ас қасық бал, 20 тамшы бұрыш жалбыз (мята перечная) тұнбасын тамызып араластырады, дәрі даяр.

Мұны қан кеткенде, асқазандағы қышқыл шамадан тыс көбейгенде, асқазан, ұлтабар, тік ішек жарасы және гемморой, панкреатит, қант диабеті, бас сақинасы сияқты дерттерге шалдыққанда, ұйқы қашқанда күніне 30 грамнан 4 рет науқастың жағдайы түзелгенше ішкізеді.

Тұқымдасы Шайқурайлар, Зверобойные - HYPERICACEAE JUSS.
Шайқурай, Зверобой - Hypericum L.

Туысы

Бұдыр шайқурай (Зверобой шероховатый – *Hypericum scabrum*) – көп жылдық жабайы өсімдік. Жартасты бойлай, тасты және қиыршық тасты беткейлерде, гранит таста өседі. Өсімдік биіктігі 40 сантиметрден 1 метрге дейін барады. Жапырағы қаулап көп шығады. Үстінде дақ құсаған қара мөлдір түктері болады. Маусым – шілде айларында сап – сары боп гүлдер ашады. Дәрі жасау үшін шайқурайдың гүлін, ұрығын, жапырағын және тамырын алады. Жуан сабағында оншама дәрілік қасиет жоқ.

Гүлін жеке кептіріп, ұнтақтап, сол ұнтақтың 50 грамын жарты литр суға демдеп күніне 100 грамнан 3 рет 15 күн ішсе, бастың сақинасын жазып, көтерілген қан қысымын қалыпты жағдайға түсіреді. Бастың соқылдап, сынып ауырғанын тоқтатады.

Енді шайқурайдың гүлі мен жапырағының қосынды ұнтағының 2 ас қасығын жарты литр суға салып 10 – 15 минут қайнатып, бір күннен кейін сүзіп, үстіне 1 ас қасық алма сірке суын қосады, дәрі даяр. Осы қайнатпаны күніне ас алдынан жарты сағат бұрын 100 грамнан 3 рет 2 ай ішетін болса, зәрді айдап, бүйрекке тас пен құмды түсіреді. Сондай – ақ бүйрек пен қуықтың қабынуын жазады. Жүрек, бауыр, бүйрек ауруларының әсерінен болған қол – аяқтың ісігін қайтарады.

Тері ауруларына қарсы шайқурай, ү сарғалдақ (чистотел), ит шоған (череда) шөптерінің әр қайсысынан 100 грамнан алып, 2 литр суға 30 минут қайнатып, ыстықтай суланған теміреткі, бітпеген жара, жазылмай жүрген қышыма қотырды ауық – ауық жуады. Артынан жарадан өзгесін алма сірке суымен сүрту керек 3 – 4 күннен кейін жанды қинап жүрген бұл сырқаттан сауыға бастайсыз. Шайқурай тамырының 3 ас қасық ұнтағын 1 литр суға 1 сағат қайнатып бір күн тұндырып, сүзіп, үстіне 30 грамм алма сірке суын қосады. Осыны күніне 30 грамнан 4 рет ішсе, қызыл иектен аққан қанды тыйып, сыздап ауырғаннан басып, босаған тісті бекітеді. Ауыздан шыққан жағымсыз иісті кетіреді. Ұрығынан жасалған қайнатпа қан аралас іш өтуді тияды. Сондай – ақ жатыр мойнағы жалақтағанда, қынап жаралағанда, жатырдың ішкі жұқа қабығы, аналық без қосалқысы қабынғанда бүрку (спринцовка) арқылы ем жасайды. Шайқурай қазіргі медицинада да дәрі жасауға кеңінен пайдаланылады. Басқа шөптермен қосса, оның емдік қасиеті арта түседі.

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Geographic Sciences

Жетісу өңірінің Текелі-Үштөбе аймағындағы 2011-2024 жылдардағы күз мезгіліндегі ауа температурасы өзгерістерінің математикалық моделін құру және болжау

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Аннотация

Бұл мақалада Жетісу өңірінің Текелі-Үштөбе аймағындағы 2011-2024 жылдар аралығындағы күз мезгіліндегі ауа температурасының өзгерістерін талдау және математикалық модель құру қарастырылған. Зерттеу барысында аймақтың қыркүйек, қазан және қараша айларындағы орташа температура деректері пайдаланылды. Уақыттық қатарларды статистикалық өңдеу және сызықтық регрессиялық талдау нәтижесінде температураның жылдар бойғы тенденциясы анықталды. Модель нәтижесі соңғы он үш жылда күз мезгіліндегі орташа температураның біртіндеп жоғарылағанын көрсетті. Зерттеу нәтижелері аймақтық климаттық динамиканы болжауға және ауыл шаруашылығында, экологиялық мониторингте қолдануға мүмкіндік береді.

Түйінді сөздер: ауа температурасы, математикалық модель, уақыттық қатар, Текелі, Үштөбе, Жетісу өңірі, регрессия, болжам.

Кіріспе

Жетісу өңірі – Қазақстанның оңтүстік-шығыс бөлігінде орналасқан табиғи-климаттық тұрғыдан ерекше аймақтардың бірі. Бұл өңірдің климаттық жағдайы континенталды сипатқа ие, алайда соңғы жылдары жаһандық климаттың жылынуы мен аймақтық антропогендік әсерлер нәтижесінде ауа температурасының тұрақты өсу үрдісі байқалуда. Текелі мен Үштөбе қалалары географиялық тұрғыдан Балқаш–Алакөл алабының оңтүстік бөлігінде орналасқан, бұл аймақтың климаттық режимі тау және жазықтық факторлардың өзара әсерімен ерекшеленеді. Күз мезгілі осы өңірдің табиғи жылдық цикліндегі өтпелі кезең болып табылады және жылдық климаттық баланстың маңызды индикаторы ретінде қарастырылады. Сондықтан 2011–2024 жылдар аралығындағы күз мезгіліндегі температура өзгерістерін талдау және болжау аймақтық климаттық процестердің бағыттарын түсінуге мүмкіндік береді.

Әдіснама және деректер

Зерттеу үшін Қазақстанның гидрометеорологиялық қызметінің мәліметтері негізінде 2011-2024 жылдар аралығындағы Текелі және Үштөбе станцияларында тіркелген қыркүйек, қазан және қараша айларының орташа температуралары алынды.

1. Деректерді алдын ала өңдеу

Барлық температуралық мәндер Цельсий шкаласында есептеліп, әр жылға күз мезгілінің орташа мәні анықталды. Жетіспейтін мәндер интерполяция әдісі арқылы толықтырылды.

2. Уақыттық қатарды талдау

Уақыттық қатардағы трендті анықтау үшін сызықтық регрессия әдісі қолданылды:
 $T(t) = a \cdot t + b + \varepsilon(t)$

3. Модельді тексеру

Модельдің сапасы келесі статистикалық көрсеткіштер арқылы бағаланды:

- детерминация коэффициенті (R^2);
- орташа квадраттық ауытқу (RMSE);
- Фишер және Стьюдент критерийлері.

4. Бағдарламалық құралдар:

Барлық есептеулер MS Excel және Python (NumPy, pandas, matplotlib) көмегімен жүргізілді

Нәтижелер және талқылау

1. Деректердің жалпы сипаттамасы

2011-2024 жылдардағы күз мезгілінің орташа температуралары $7,8^{\circ}\text{C}$ – $10,4^{\circ}\text{C}$ аралығында болды. Бастапқы кезеңде (2011–2014 жж.) температура шамамен 8°C шамасында болса, 2020 жылдан кейін 10°C деңгейіне дейін көтерілгені байқалды. Жалпы тенденция – температураның жыл сайын орта есеппен $0,12^{\circ}\text{C}$ -қа өсуі.

2. Сызықтық модель нәтижелері

Сызықтық регрессия теңдеуі төмендегідей алынды:

$$T(t) = 0,123 \cdot t + 6,85$$

Бұл теңдеу жыл сайын температураның орта есеппен $0,12^{\circ}\text{C}$ -қа өсіп отырғанын көрсетеді.

Модельдің детерминация коэффициенті $R^2 = 0,78$, яғни модель деректердің 78%-ын дәл сипаттайды.

3 Берілген мәліметтерді сипаттау және өңдеу

Зерттеу үшін 2011–2024 жылдар аралығындағы Текелі және Үштөбе станцияларында тіркелген қыркүйек, қазан және қараша айларының орташа температуралары пайдаланылды. Алынған деректер келесі сипаттамаларға ие:

- Орташа күзгі температура $7,8^{\circ}\text{C}$ – $10,4^{\circ}\text{C}$ аралығында өзгерді.
- 2011–2014 жылдарда температура шамамен 8°C болса, 2020 жылдан кейін 10°C деңгейіне дейін көтерілді.
- Орташа температураның жыл сайынғы өсімі шамамен $0,12^{\circ}\text{C}$.

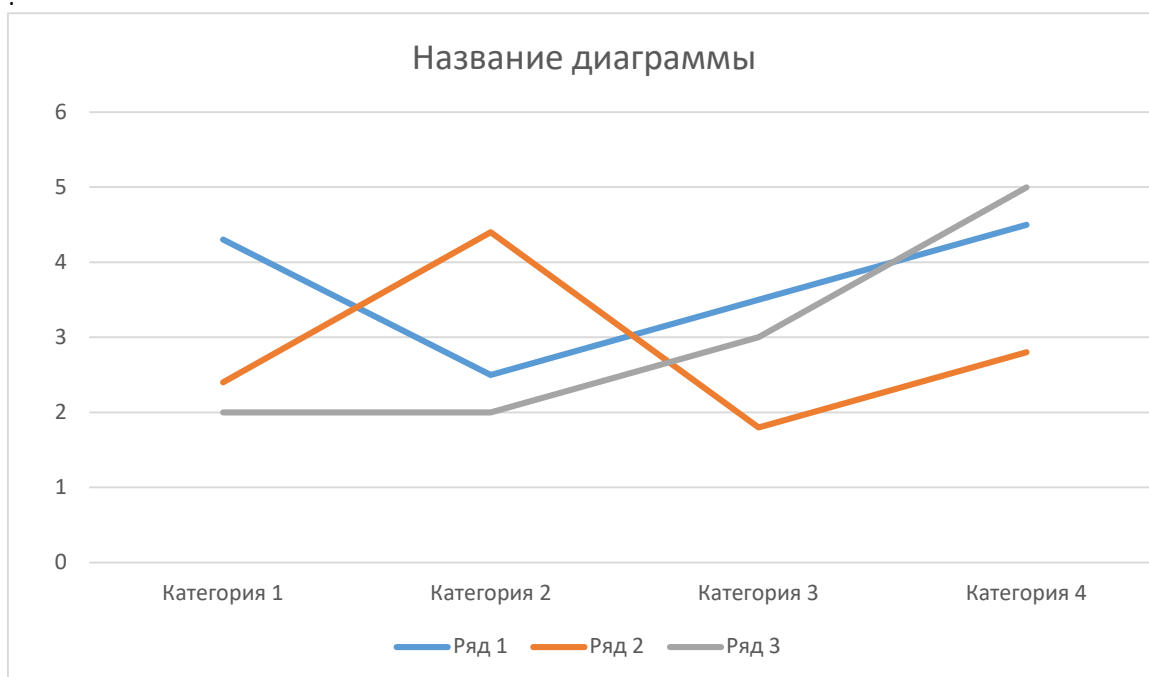
Кесте 1. 2011-2024 жылдардағы күзгі орташа температура (°C)

Жыл	Қыркүйек	Қазан	Қараша	Орташа температура
2011	16,7	9,2	0,9	8,93
2012	16,7	9,4	-6,0	6,7
2013	17,3	11,7	2,3	10,43
2014	15,4	7,9	0,1	7,8
2015	12,5	10,1	2,0	8,2
2016	18,5	4,9	-9,0	4,8
2017	16,0	9,1	3,5	9,53
2018	14,6	8,8	-1,7	7,23
2019	16,2	10,1	-0,8	8,5
2020	17,4	10,4	2,1	9,97
2021	17,4	6,2	0,7	8,1
2022	18,6	9,6	1,2	9,8
2023	14,9	11,8	7,3	11,33
2024	13,5	10,2	4,5	9,4

Орташа температура = (қыркүйек + қазан + қараша)/3

Графиктер:

- Барлық жылдар бойынша күзгі орташа температураның өзгеру графигін Excel немесе Python арқылы тұрғызуға болады.
- Лаг L = 1,2,3,4 үшін коррелограмма құру арқылы уақыттық қатардағы автокорреляцияны бағалау
- .



3.1 Математикалық модель

Орташа күзгі температураның өзгеруін модельдеу үшін **сызықтық регрессия** қолданылды. Модель теңдеуі:

$$T(t) = a \cdot t + b$$

- $T(t)$ – t жылындағы орташа температура
- a, b – регрессия коэффициенттері

Есептеу нәтижесі:

$$T(t) = 0,123 \cdot t + 6,85$$

- Модель жыл сайынғы орташа өсімді $0,12^\circ\text{C}$ көрсетеді.
- Детерминация коэффициенті $R^2 = 0,78$ (деректердің 78%-ын түсіндіреді).
- Орташа квадраттық ауытқу (RMSE) = 0,95

Болжам (2025–2028):

Жыл	Орташа температура, $^\circ\text{C}$
2025	10,6
2026	10,7
2027	10,8
2028	10,9

Климаттық факторлардың ықпалы:

- Атмосфералық циркуляцияның өзгеруі
- Жауын-шашын мен бұлттылықтың төмендеуі
- Антропогендік әсерлер: өнеркәсіп, көлік, урбанизация

Талқылау:

- Модель соңғы он үш жылда температураның тұрақты өсу тенденциясын дәлелдейді.
- Бұл үрдіс жаһандық климаттың жылынуымен және аймақтық антропогендік факторлармен үйлеседі.

4. Климаттық факторлардың әсері

Температураның көтерілуіне ықпал ететін негізгі факторлар:

- атмосфералық циркуляцияның өзгеруі;
- жауын-шашын мен бұлттылықтың төмендеуі;
- антропогендік факторлар (өнеркәсіп, көлік, урбанизация).

5. Талқылау

Модель нәтижелері соңғы он үш жылдағы күзгі температураның тұрақты түрде жоғарылау тенденциясын дәлелдейді. Бұл климаттың жалпы жылыну үрдісімен және жаһандық климаттық өзгерістермен сәйкес келеді.

Қорытынды

Жүргізілген зерттеу нәтижесінде Текелі-Үштөбе аймағындағы 2011-2024 жылдар аралығындағы күз мезгіліндегі ауа температурасының уақыттық өзгерісіне арналған математикалық модель құрылды. Модель жыл сайын орташа температураның **$0,12^\circ\text{C}$ -қа өсу тенденциясын** көрсетті. Бұл өзгерістер аймақтық климаттың жылыну бағытын айқындайды. Зерттеу нәтижелері ауыл шаруашылығын жоспарлау, экологиялық мониторинг және аймақтық климаттық саясатты қалыптастыру үшін қолдануға ұсынылады.

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İrqi Ayır-Seçkiliyin Qarşısının Alınması Üzrə Qlobal Tədbirlər və Beynəlxalq Mübarizə

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Açar sözlər: İrqi Ayır-seçkilik, Beynəlxalq Konvensiya, ICERD, Durban Konfransı,

CERD Komitəsi

İrqi ayır-seçkilik bəşəriyyətin üzləşdiyi ən qədim və dağıdıcı problemlərdən biri olaraq qalır. Buna qarşı qlobal mübarizə, əsasən, İkinci Dünya Müharibəsindən sonra, Birləşmiş Millətlər Təşkilatının (BMT) yaranması ilə intensivləşmişdir. Bu mübarizə beynəlxalq hüquqi sənədlər, institusional mexanizmlər və dövlət səviyyəsində tətbiq olunan strategiyalar vasitəsilə həyata keçirilir.

I. Beynəlxalq Hüquqi Bazanın Əsası: BMT-nin Əsas Konvensiyası

İrqi ayır-seçkiliyə qarşı mübarizənin hüquqi özəyi 1965-ci ildə BMT Baş Assambleyası tərəfindən qəbul edilmiş və 1969-cu ildə qüvvəyə minmiş "İrqi Ayır-seçkiliyin Bütün Formalarının Ləğv Edilməsi Haqqında Beynəlxalq Konvensiyadır" (ICERD).

1. ICERD Konvensiyasının Əsas Öhdəlikləri:

ICERD Konvensiyası iştirakçı dövlətlərə bir sıra fundamental öhdəliklər qoyur:

* İrqi Ayır-seçkiliyin Tərif: Konvensiya irqi ayır-seçkiliyi irq, dərinin rəngi, nəsil, milli, yaxud etnik mənşə əlamətlərinə əsaslanan və insan hüquqlarının və əsas azadlıqlarının bərabər tanınmasını, istifadəsini, yaxud həyata keçirilməsini ləğv etmək və ya pisləşdirmək məqsədi daşıyan hərəkətlər kimi müəyyən edir (Maddə 1).

* Aparteidin Qınanması: Konvensiya aparteid kimi irqi seqreqasiya və ayır-seçkiliyin dövlət siyasəti xarakterli bütün praktikalarını xüsusilə pisləyir və qadağan edir (Maddə 3).

* İrqi Təbliğatın Qadağan Edilməsi: İştirakçı dövlətlər irqi üstünlüyə və ya nifrətə əsaslanan istənilən təbliğatın və təşkilatın yayılmasını qanunla qadağan etməyi öhdələrinə götürürlər (Maddə 4).

* Hüquqi Müdafiə: Dövlətlər hər bir şəxsin irqi ayır-seçkilik aktlarından qorunmasını və effektiv hüquqi müdafiə vasitələri ilə təmin edilməsini öhdəsinə götürür (Maddə 6).

* Təhsil Tədbirləri: İrqi ayır-seçkiliyə gətirib çıxaran xurafatla mübarizə aparmaq üçün tədris, tərbiyə, mədəniyyət və informasiya sahələrində tədbirlərin görülməsi tələb olunur (Maddə 7).

II. Beynəlxalq Nəzarət və Monitoring Mexanizmləri

Beynəlxalq hüquqi sənədlərin tətbiqinə nəzarət etmək üçün BMT çərçivəsində xüsusi orqanlar yaradılmışdır.

1. İrqi Ayır-seçkiliyin Ləğv Edilməsi üzrə Komitə (CERD)

* Funksiyası: Bu orqan ICERD Konvensiyasına qoşulan dövlətlərin öhdəliklərini necə yerinə yetirdiyini monitoring edən ən mərkəzi nəzarət mexanizmidir.

* Fəaliyyəti: İştirakçı dövlətlər Komitəyə müntəzəm olaraq (adətən iki ildən bir) ölkədə irqi ayır-seçkiliklə mübarizə sahəsində görülmən tədbirlər haqqında hesabatlar təqdim edirlər. Komitə bu hesabatları və qeyri-hökumət təşkilatlarından alınan məlumatları təhlil edərək, dövlətə yekun rəy və tövsiyələr verir.

* Fərdi Şikayətlər: Konvensiyanın 14-cü maddəsini tanıyan dövlətlərə qarşı, ayır-seçkiliyə məruz qalmış şəxslərin fərdi şikayətlərini qəbul edir və araşdırır.

2. Durban Konfransı və Fəaliyyət Proqramı

2001-ci ildə Cənubi Afrikanın Durban şəhərində keçirilən İrqqiliyə, İrqi Ayrı-seçkiliyə, Ksenofobiyaya və Əlaqəli Dözümsüzlüyə Qarşı Ümumdünya Konfransı irqçiliklə mübarizədə dönüş nöqtəsi oldu. Konfransın nəticəsi olan Durban Bəyannaməsi və Fəaliyyət Proqramı müasir irqçilik formalarına (o cümlədən, internetdəki ksenofobiya, miqrantlara qarşı ayrı-seçkilik) qarşı mübarizə üçün geniş strategiyalar müəyyən etdi.

III. Milli Səviyyədə Tətbiq Edilən Tədbirlər

Beynəlxalq öhdəlikləri yerinə yetirmək üçün dövlətlər öz daxili qanunvericiliklərində və siyasətlərində bir sıra tədbirlər həyata keçirirlər:

1. Qanunvericilik və Cəza Mexanizmləri

* Diskriminasiya Əleyhinə Qanunlar: Bir çox ölkə məşğulluq, təhsil, mənzil və ictimai xidmətlər sahəsində irq, etnik mənşə və ya din əsasında ayrı-seçkiliyi qadağan edən xüsusi qanunlar qəbul etmişdir.

* Nifrət Cinayətlərinin Cəzalandırılması: İrqi nifrət motivindən törədilən cinayətlər (nifrət cinayətləri) üçün daha ağır cəzaların tətbiqi.

* İrqi Təşkilatların Qadağan Edilməsi: İrqi nifrəti təşviq edən partiya, dərnək və ya hər hansı bir qrupun fəaliyyətinin qanunla məhdudlaşdırılması və ya qadağan edilməsi.

2. Müsbət Fəaliyyət və Kompensasiya Tədbirləri

Mövcud bərabərsizlikləri aradan qaldırmaq üçün bəzi ölkələr xüsusi və müvəqqəti tədbirlər tətbiq edir (BMT-nin CERD Komitəsi tərəfindən də dəstəklənir):

* "Affirmative Action" (Müsbət Fəaliyyət) Proqramları: Tarixən ayrı-seçkiliyə məruz qalmış qrupların universitetlərə qəbulunda, dövlət qurumlarında və ya böyük şirkətlərdə işə götürülməsində bərabərlik yaratmaq məqsədilə ünvanlı tədbirlər görmək.

* Kvota Sistemləri: Bəzi hallarda, müəyyən sahələrdə azlıqların təmsilçiliyini artırmaq üçün konkret müddətlərlə bağlı real məqsədlər və ya kvota sistemləri tətbiq edilə bilər.

3. Təhsil və Mədəniyyət Tədbirləri

İrqi ayrılığın kökünü kəsmək üçün ən effektiv uzunmüddətli strategiya təhsil və cəmiyyətdaxili tolerantlığın təşviq edilməsidir:

* Multikulturalizm və Tolerantlıq Təhsili: Məktəb proqramlarına fərqliliyə hörməti, mədəniyyətlərə anlaşılan və irqi bərabərliyi təbliğ edən modulların daxil edilməsi.

* 21 Mart Beynəlxalq Mübarizə Günü: BMT tərəfindən 21 mart İrqi Ayrı-Seçkiliyin Ləğv Olunması Uğrunda Beynəlxalq Mübarizə Günü elan edilmişdir. Bu gün bütün dünyada irqçilik əleyhinə kampaniyalar, tədbirlər və məlumatlandırma aksiyaları keçirilir.

* Media və İnformasiya: Medianın nifrət nitqinin və irqi stereotiplərin yayılmasının qarşısını alması üçün beynəlxalq prinsiplərin və kodekslərin tətbiqi.

IV. Regional Təşəbbüslər

Qlobal səylərlə yanaşı, regional təşkilatlar da irqçiliklə mübarizədə mühüm rol oynayır:

* Avropa Şurası (AŞ): İnsan Hüquqları üzrə Avropa Konvensiyası və İrqiçilik və Dözümsüzlük Əleyhinə Avropa Komissiyası (ECRI) irqçiliklə bağlı vəziyyəti monitorinq edir və üzv dövlətlərə fərdi tövsiyələr verir.

* Avropa İttifaqı (Aİ): Bərabər Rəftar Direktivi kimi sənədlər və Fundamental Hüquqlar Agentliyi (FRA) vasitəsilə Aİ daxilində irqi ayrı-seçkiliyin qarşısının alınmasına dair siyasətlər həyata keçirir.

Nəticə

İrqi ayrı-seçkiliyin aradan qaldırılması uzun və davamlı bir prosesdir. Beynəlxalq Konvensiyalar, xüsusilə ICERD, qlobal miqyasda hüquqi baza yaratmışdır. Lakin effektiv mübarizə tək cəmiyyətlərin qəbul edilməsi deyil, həm də onların milli səviyyədə vicdanla tətbiq edilməsi, müsbət fəaliyyət proqramlarının həyata keçirilməsi və bütün cəmiyyət üzvlərinin tolerantlıq ruhunda tərbiyə edilməsi ilə mümkündür. 21 Mart bu qlobal öhdəliyin hər il xatırladılması üçün mühüm bir simvoldur.

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WHAT IS THE IMPACT OF AI ON SCHOOL STUDENTS' COMMUNICATIVE SKILLS?

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Abstract

This article provides a comprehensive analysis of the use of artificial intelligence in foreign language teaching and its impact on the development of students' communicative skills. Key areas of AI use, such as adaptive educational platforms that enable individualized learning, instant automatic assessment systems that improve the quality of feedback, chatbots and virtual companions that create a safe and motivating environment for developing oral communication and tools that facilitate the improvement of written literacy and stylistic expressiveness are discussed. The advantages of AI implementation are highlighted, including increased motivation, access to personalized learning resources, the opportunity for continuous practice, and reduced anxiety when communicating in a foreign language.

Particular attention is paid to the limitations of technology: the lack of meaningful emotional interaction, insufficient transmission of sociocultural aspects of language, and the risk of developing excessive dependence on digital tools. The need for thoughtful integration of AI into the educational process, where it serves as a complement to, rather than a substitute for, pedagogical expertise is emphasized. In conclusion, the article argues that the rational use of AI can make learning more flexible, effective, and focused on the real communicative needs of students.

Introduction

In recent decades, artificial intelligence (AI) has rapidly penetrated various spheres of human life, significantly impacting economics, science, social and everyday life. Education is no exception: modern technologies are being integrated into the educational process, creating new conditions for developing competencies and increasing the effectiveness of learning. While AI innovations were previously primarily associated with medicine, financial analysis, or industrial automation, today more and more research is devoted to exploring its potential in pedagogy, particularly in the field of foreign language teaching.

Of particular interest is the impact of AI on the development of communicative skills that promotes successful language learning: speaking, writing, listening, and interactive communication. The emergence of chatbots, automatic pronunciation assessment systems and adaptive platforms offers learners new opportunities to practice language as close as possible to real-life interactions.

Students using AI in their English language learning experience personalized learning paths, instant feedback, and unlimited opportunities to practice speaking and other communicative skills. However, such rapid adoption of technology requires reflection: it is important to evaluate existing methods, identify their strengths and limitations, and determine how AI can be most effectively integrated into educational practices. All of this makes analyzing the role of artificial intelligence in developing students' communication skills particularly relevant in the modern educational context.

Individualizing the Pace of Learning

Traditional educational models do not rely on an individual approach, which does not always meet the needs of every student. Modern educational platforms like Duolingo, Babbel, and

others actively use AI to tailor the learning process to individual students. Artificial intelligence analyzes each student's progress and, based on this data, adapts lessons to their level. This individualization is especially important in language learning, where each student needs time to master certain skills. Using AI gives the control over the difficulty of assignments, focusing on weaknesses, and changing the learning process according to it, which, in turn, promotes deeper learning.

Furthermore, AI helps students feel more confident, as they can work with platforms at their own pace, free from peer or teacher pressure. This flexibility allows each student to develop at their own pace, which is essential for maintaining motivation and interest in learning.

Instant Assessment

One of the most significant aspects of using AI in education is the ability to receive instant feedback. Many modern language learning apps offer automatic grammar, spelling, pronunciation, and style checking. Services like Grammarly and Microsoft Editor are excellent tools for students, as they immediately identify errors and suggest corrections. This promptness allows students not only to avoid making the same mistakes again but also to master correct versions more quickly.

This approach makes the language acquisition process faster, as students receive constant feedback, which contributes to a higher quality of learning. Moreover, the ability to instantly correct errors helps boost students' confidence, especially as they begin to develop oral and written skills in a new language environment.

Chatbots as a Practice Tool

In recent years, chatbots have gained immense popularity as an effective tool for language practice. One striking example is the use of ChatGPT as a virtual conversational partner that can simulate various real-life situations. Students can communicate with the AI in English, practicing their speaking skills without the fear of making mistakes. This is especially useful for students who are shy about speaking a foreign language or who do not have the opportunity to communicate with native speakers.

Chatbots allow students to practice important communication skills such as responding to questions, constructing responses and dialogues. While AI cannot completely replace human interaction, it serves as an excellent complement to traditional teaching methods by creating a safe environment for practice.

Improving Writing with AI

Equally important is the impact of AI on the development of writing skills. Modern tools like Grammarly allow students not only to correct grammar errors but also to enhance the style and structure of their writing. These tools can suggest improvements in word choice, simplifying sentence structure, and increasing the accuracy of their statements. For older students studying a language at a more advanced level, this represents an additional opportunity to improve their writing skills and achieve higher proficiency.

AI also helps students learn how to construct arguments correctly, improve their vocabulary, and develop the ability to express themselves clearly and logically. Ultimately, this contributes to the quality of their writing and helps students prepare for exams and tests for higher grades.

Limitations of AI

Despite its enormous advantages, the use of AI in education also has its limitations. Firstly, as mentioned before, AI cannot replace live interaction with native speakers. Interacting with people not only improves pronunciation but also provides an opportunity to learn language features such as idiomatic expressions, slang, and subtle sociocultural nuances. Interacting with real people helps students develop non-verbal communication skills such as intonation, facial expressions, and gestures, which cannot be fully achieved with AI.

Furthermore, there is a risk that students may become overly dependent on AI, relying on it for learning. This can lead to them failing to develop independent problem-solving skills and losing critical thinking about their own knowledge. Therefore, it is important to use AI wisely, which should complement traditional teaching methods rather than replace them.

Prospects for AI in Language Education

In the future, we can expect further expansion and development of the use of AI in education. Virtual reality, as well as interactive systems with AI elements, can significantly improve the learning experience. It is expected that in the future, systems will be integrated that will not only correct errors but also actively interact with students, helping them better understand the context and use language in various situations.

Furthermore, AI may be integrated into virtual reality classrooms, where students will be able to communicate with virtual native speakers and immerse themselves in the culture and environment of the target language. Such learning will be not only effective but also engaging.

Conclusions

On the whole, artificial intelligence has significant potential for improving the process of foreign language learning and, in particular, the development of students' communicative skills. Intelligent systems make learning more accessible, flexible, and personalized, taking into account the individual characteristics, learning pace, and needs of each student. With its immediate feedback capabilities, adaptive tasks, and simulated real-life communicative situations, AI can enhance student motivation and create opportunities for regular language practice outside of traditional classroom settings.

However, despite its wide range of benefits, it's important to consider the limitations of technology. Artificial intelligence cannot fully replace the real-life interaction, emotional support, and pedagogical guidance provided by a teacher. Furthermore, overreliance on digital tools can reduce critical thinking while learning and minimize the diversity of communicative experiences. Therefore, it's crucial to ensure a balanced approach to integrating AI into the educational process, with technology serving as a supporting rather than a dominant element of learning.

The optimal use of AI lies in its role as a valuable complement, empowering both teachers and students. By freeing teachers from routine tasks, AI allows them to focus on creative and methodologically challenging aspects of teaching: creating meaningful assignments, facilitating discussions, and developing critical thinking. The result is a more efficient, harmonious, and student-focused educational process, in which AI serves as a tool for improving the quality of learning, rather than as a replacement for it.

Architecture

ENVIRONMENTAL AND SOCIAL EFFECTS OF MIXED-USE DEVELOPMENT: THE EXPERIENCE OF ALMATY AND DIRECTIONS FOR SUSTAINABLE DEVELOPMENT

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Annotation

The article is devoted to the analysis of the ecological and social effects of mixed-use development in the context of Almaty. It examines the advantages and challenges associated with integrating residential, commercial, and public functions within a single urban space. Special attention is paid to the impact of mixed-use development on ecological sustainability, the reduction of traffic load, the creation of a comfortable urban environment, and the enhancement of social activity among residents. The article also presents directions for sustainable development in Almaty, including the implementation of "green" design standards, optimization of urban space utilization, and improvement of urban infrastructure quality. The findings can be used in the development of strategies for metropolitan growth and the formation of modern architectural and urban planning policies.

Keywords: *mixed-use development, sustainable development, urban environment, ecology, social effects, Almaty, urban planning, comfortable environment.*

The development of mixed-use complexes is considered in contemporary scientific literature as one of the most effective tools for creating sustainable urban areas. This concept is based on the integration of residential, commercial, public, recreational, and cultural functions within a single architectural and planning space. For Almaty, the largest metropolis in Kazakhstan, mixed-use development acquires particular significance due to rapid urbanization, ecological challenges, increasing traffic loads, and the necessity to optimize land use within a limited territory constrained by topography and natural boundaries.

Mixed-use development allows for the solution of a complex set of interconnected tasks: ensuring the compactness of the urban structure, improving the ecological situation, creating a comfortable environment for residents, and promoting social interaction. However, the effectiveness of its implementation depends on the quality of urban planning, the level of infrastructure provision, adherence to ecological standards, and the degree of integration of such projects into the broader urban context. The examination of the ecological and social effects of mixed-use development, using Almaty as a case study, allows for the identification of both positive trends and existing problems that require scientific analysis and further improvement.

One of the key ecological effects of mixed-use development is the reduction of traffic load. In cities with high population density and a strong dependence on private vehicles, air pollution often reaches critical levels. Almaty, located in a basin, is particularly sensitive to exceeding permissible emission limits, as unfavorable air circulation and temperature inversions contribute to the accumulation of smog. Mixed-use development reduces the need for daily commuting because essential functions - work, leisure, education, and shopping - are concentrated within walking distance. This leads to a decrease in vehicle movements and, consequently, a reduction in carbon dioxide emissions, fine particulate matter, and other pollutants.

In addition, mixed-use development promotes the rational use of land resources. Its compact and vertical structure reduces the need for the expansion of peripheral urban areas, which helps preserve natural territories and prevent landscape degradation. For Almaty, where a significant portion of valuable natural zones is located within the city limits - along rivers, in foothills, and green areas - preserving the natural environment is a critical aspect of sustainable urban development.

An important advantage of mixed-use development is the potential integration of environmentally oriented technologies, such as energy - efficient facades, green roofs, rainwater collection systems, solar panels, and landscape solutions to mitigate the urban heat island effect. In Almaty, characterized by high solar radiation, the use of solar energy can significantly reduce the load on the city's power networks. However, these practices are currently implemented only partially, highlighting the need for mandatory green building standards.

The social benefits of mixed-use development are also among the key factors determining its demand in modern megacities. The integration of various functions within a single urban space fosters human capital development, enhances social activity, and strengthens local communities.

One of the most significant social effects is the improvement of urban comfort. Residents of mixed-use districts have access to a variety of services - educational, medical, cultural, and everyday - without the need for long trips. In Almaty, where many areas experience a shortage of public infrastructure, mixed-use complexes can compensate for these deficiencies, addressing the needs of diverse social groups, including youth, families with children, and the elderly.

An additional social effect of mixed-use development is the enhancement of urban safety. The high density of active functions ensures a constant presence of people in public spaces, which contributes to a reduction in crime levels and improves the subjective sense of security. This principle is widely applied in international practice and is based on Jane Jacobs "eyes on the street" concept, which posits that social control increases through the continuous presence of people in urban areas. In Almaty, this is particularly relevant for new districts, where the long-standing problem of mono-functional development and lack of active urban life has persisted.

Equally important is the influence of mixed-use development on the formation of urban identity. Such complexes create new focal points - cultural centers, public spaces, and retail and entertainment areas - that become integral to residents' daily lives and contribute to the creation of a unique urban image. Almaty, with its rich cultural heritage, can utilize mixed - use development as a tool for establishing new modern urban centers that reflect the dynamic development of the metropolis.

Despite the obvious advantages, the implementation of mixed-use development in Almaty faces several challenges. One of the most significant is the mismatch between existing transport infrastructure and the requirements of new high-density districts. A shortage of parking spaces, overloaded main roads, and insufficient public transport lead to traffic congestion.

Another challenge is the insufficient integration of mixed-use complexes into the urban environment. Some projects are designed as enclosed spaces, poorly connected to surrounding neighborhoods, resulting in the fragmentation of the urban structure and hindering the

development of a vibrant city life. This highlights the need to shift from fragmented solutions toward a systematic urban planning policy.

The sustainable development of mixed - use complexes in Almaty is a complex and multi-layered process that requires the alignment of urban planning, architectural, economic, ecological, and social strategies. In the context of rapid urban agglomeration growth, increasing complexity of transportation and ecological conditions, and high population density, the development of effective sustainable strategies becomes a determining factor for the future quality of the urban environment. Mixed-use development, as one of the most promising models of contemporary urban planning, has the potential to become a key instrument for implementing sustainable architectural and planning policies. However, achieving this requires a profound transformation of approaches to the design and development of urban territories in Almaty.

Formation of a Polycentric Urban Structure. One of the strategic directions for the sustainable development of mixed - use development is the transition from a monocentric structure in Almaty to a polycentric model. At present, a significant portion of business, administrative, and cultural activities is concentrated in the central districts, which leads to the overloading of transport corridors, uneven population distribution, and a decrease in urban quality of life.

Creation of Secondary and Tertiary Urban Activity Centers. The establishment of new centers in different parts of Almaty will help redistribute social and transport flows, increase accessibility to services, and improve the overall quality of life. Mixed-use development serves as the core of these centers, providing a combination of workplaces, service facilities, public spaces, and recreational areas. For the polycentric model to function effectively, these urban activity centers must be connected by high-speed transport routes and transfer hubs, which reduces dependence on private vehicles.

Application of Energy - Efficient Technologies. Mixed-use complexes should be designed using passive solar heating systems, next-generation thermal insulation materials, energy recovery systems, and smart energy management networks. These measures help reduce energy consumption for heating and cooling, which is particularly relevant given Almaty's highly variable climate.

The use of green roofs, vertical landscaping, winter gardens, and biophilic facades decreases the thermal load on the city and improves the microclimate. Such solutions contribute to increased humidity levels, the mitigation of the urban heat island effect, improved air quality, and the creation of comfortable recreational zones.

Effective management of stormwater and meltwater is one of the key aspects of the sustainable development of mixed-use complexes. In Almaty, where intense rainfall and snowmelt can overload urban infrastructure, it is essential to design systems capable of collecting, filtering, and reusing water. Mixed-use developments should incorporate local treatment facilities, permeable pavements, biofilters, and rainwater storage tanks. These measures not only reduce the burden on central drainage networks but also create additional opportunities for landscaping and the formation of a comfortable microclimate. Thus, water management becomes not only an engineering task but also a tool for enhancing the quality of the urban environment.

The development of transport and pedestrian infrastructure is a necessary condition for the functional sustainability of mixed-use complexes. Improving access to public transportation reduces dependence on private vehicles, lowers air pollution, and alleviates traffic congestion. A key element is the integration of new mixed-use districts with existing bus, tram, and rapid transit lines, as well as the creation of transfer hubs to efficiently distribute passenger flows. Pedestrian infrastructure also plays a critical role: wide and safe sidewalks, convenient crossings, shaded and green corridors encourage walking, foster social interaction, and enhance the quality of urban life.

Additionally, the development of a bicycle network, including bike lanes, parking, and rental stations, promotes alternative mobility and supports ecological sustainability.

The social sustainability of mixed-use development is closely linked to the creation of high-quality public spaces. Open and accessible parks, squares, gardens, and cultural event areas stimulate active participation by residents, foster inter-social interaction, and help build local communities. A key principle is functional diversity: spaces should include recreational areas, sports zones, playgrounds, and cultural and educational facilities. Special attention should be paid to landscape design and microclimate: greenery, water features, shaded structures, and convenient urban furniture increase comfort, create a pleasant urban environment, and support social activity throughout the year.

The accessibility of mixed-use complexes for various population groups is another key aspect of sustainable development. Design must take into account low-mobility groups, including people with disabilities, elderly residents, and families with children. This involves the provision of ramps, elevators, tactile surfaces, and barrier-free routes. An important component of social sustainability is also housing affordability: complexes should include housing of different price categories, ensuring the integration of diverse social groups and reducing population segregation. The creation of social infrastructure - schools, kindergartens, medical centers, cultural and recreational facilities - makes neighborhoods self-sufficient and improves the quality of life for all residents.

The implementation of digital technologies and “smart city” systems further enhances the sustainability of mixed-use development. Air quality monitoring, energy consumption control, automation of ventilation and lighting systems, and digital tracking of pedestrian flows all increase the efficiency of complex management, optimize resource use, and create a safer and more comfortable urban environment. Smart management systems also allow infrastructure to adapt to changing conditions, thereby increasing the overall resilience of urban areas.

Mixed-use development represents a key instrument of contemporary urban planning, capable of addressing ecological, social, and economic challenges in a comprehensive manner. Using Almaty as a case study, it can be observed that the implementation of mixed-use complexes has a multifaceted impact on urban quality of life. Ecological effects include the reduction of traffic load and pollutant emissions due to the concentration of residential, commercial, and public functions within a single district. The compactness of development promotes efficient land use, prevents uncontrolled urban sprawl, and preserves natural zones that are especially valuable in a city located within a mountainous basin.

The social aspects of mixed-use development are reflected in improved urban comfort, accessibility to public services, and the formation of active urban communities. The presence of diverse public spaces - squares, parks, cultural venues, and children’s areas - supports the integration of different social groups, fosters interpersonal connections, and enhances safety. Social sustainability is further ensured through the availability of housing in various categories, the implementation of inclusivity principles, and the design of infrastructure accessible to low-mobility groups. These elements collectively contribute to the overall quality of the urban environment, promoting residents well-being and the development of social identity.

Analysis of Almaty’s experience reveals that, despite positive trends, several challenges require a systematic approach. These include insufficient integration of mixed-use complexes into the transport system, overloaded infrastructure, a lack of public spaces and greenery in some districts, and the partial implementation of green technologies and energy-efficient solutions. These shortcomings highlight the need to move from isolated construction initiatives to strategic urban planning based on sustainable development principles.

The key directions for the further development of mixed-use development in Almaty include the formation of a polycentric urban structure, the integration of modern transport and

pedestrian systems, the implementation of comprehensive ecological technologies, the creation of open and multifunctional public spaces, digitalization and “smart” infrastructure management, as well as the promotion of social inclusivity and accessibility. These directions require systematic coordination of architectural design, engineering infrastructure, environmental policies, and social programs, which allows for achieving a synergistic effect and enhancing the resilience of the urban environment.

Overall, mixed-use development can serve as the foundation for a new stage of sustainable development in Almaty, capable of combining economic growth with environmental safety and social harmony. Scientifically grounded planning and the comprehensive implementation of mixed-use complexes will enable the creation of high-quality urban areas that can adapt to dynamically changing urbanization, climatic, and social challenges. Thus, mixed-use development is considered not only as an architectural design tool but also as a strategic mechanism for implementing the concept of a sustainable, environmentally safe, and socially oriented city of the future.

The implementation of these sustainable development directions will require close collaboration among government authorities, architects, engineers, urban planners, ecologists, and city residents. Such cooperation will help create an environment that meets modern standards of comfort, safety, and ecological harmony. In the long term, a comprehensive and scientifically grounded strategy for mixed-use development could become an example of the successful integration of innovation and tradition, ensuring the sustainable and balanced development of Almaty as a leading metropolis in Central Asia.

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Proceedings of the 11th International Scientific Conference
«Interdisciplinary Science Studies» (December 4-5, 2025). Dublin, Ireland,
2025. 547p

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