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General Information

About the Journal

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The journal publishes original research articles, theoretical analyses, and methodological developments in the following areas:

1. Innovative Approaches and Practices in Modern Education;
2. Psychological and Pedagogical Problems of Professional Development of Education Specialists.

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5. Collective decision-making based on expert consensus;
6. Efficient and transparent communication with authors;
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The Symbiosis of Silicon and Neuron: Hybridizing Cognitive Habitus and the Sociological Transformation of Genius in Gifted Students

Abstract

Introduction. The study addresses the sociological transformation of giftedness and genius in the context of artificial intelligence, examining how the boundaries between human cognition and algorithmic systems are becoming increasingly blurred in the contemporary digital era. Consequently, traditional conceptions of giftedness, grounded in biological determinism and individual cognitive performance, require reconsideration, as they no longer adequately account for the cognitive experiences of gifted students engaging with AI technologies. *Methodology and Methods*. The study employed a conceptual and intertextual analysis strategy grounded in a post-humanist theoretical framework. Drawing on Pierre Bourdieu's habitus theory, Actor-Network Theory, and the Extended Mind Hypothesis, the research systematically reviewed national and international academic literature from databases including Web of Science, Scopus, ERIC, Google Scholar, and JSTOR. *Results*. The findings indicate that gifted students experience AI not merely as a functional tool but as an extension of their cognitive processes, giving rise to a "hybridized cognitive habitus" in which emotion, intuition, and algorithmic thinking converge. Furthermore, cognitive processes integrated with AI restructure cultural capital through algorithmic competencies, generating a new form of digital cognitive elitism. *Scientific novelty*. The scientific novelty lies in introducing the concept of "Symbiotic Genius" and "hybridized cognitive habitus" as new theoretical frameworks that redefine giftedness beyond biological boundaries within the age of artificial intelligence. *Practical significance*. The results can be used to reconceptualize educational policies, curriculum design, and social adaptation strategies to align with the emerging hybrid cognitive reality of gifted students, while also addressing issues of cognitive justice and equal access to AI technologies in education.

Keywords: Cognitive Habitus, Digital Capital, Sociology of Education, Post-Humanism, Symbiotic Genius, Giftedness, Artificial Intelligence.

Introduction. Throughout human history, the concepts of intelligence and genius have been considered a reflection of a person's biological limitations and their relationship with the society in which they live. In traditional literature, "superior ability" has been conceptualized as an "isolated" form of achievement where inherited potential is enhanced by environmental factors (Renzulli, 2021; Sternberg, 2018). However, the digital transformation of the 21st century is shaking this biological determinism, creating an ontological rupture in which neural capacity and algorithmic systems are intertwined.

Intelligence is no longer merely a processing unit within the skull, but the dynamic result of a symbiotic network built using silicon-based methods. When this transformation is considered within the theoretical framework of post-humanist discussions (Braidotti, 2013, 2016; Hayles, 1999; Saldanha, 2023), the human-machine relationship is understood not only as a technological but also as an ontological restructuring. In this context, the Homo Deus discussions by Harari (2016) and Tegmark (2018) point to the process of redefining humans' cognitive and biological limits through algorithmic systems.

To understand the sociological dimension of this transformation, Bourdieu's (2020) concept of "habitus" provides an important

theoretical foundation. While habitus represents the perceptions, thoughts, and actions that determine a person's position in society, for today's gifted individuals, these structures are now intertwined not only with physical and social interactions but also with algorithmic interactions.

While current discussions on "Digital Habitus" (Ignatow & Robinson, 2017; Wynn, 2024) offer significant contributions to explaining the technology-society relationship, they are limited in explaining the process by which gifted minds internalize artificial intelligence not merely as a tool, but as a "cognitive prosthesis" or "mental extension" (Lupton, 2020).

In this context, the study aims to examine how traditional definitions of genius are being transformed amid digital change by addressing gifted students' interactions with artificial intelligence from a sociological perspective. The research aims to demonstrate that the concept of giftedness is being reshaped not only through individual cognitive capacity but also through interactions with algorithmic systems.

Materials and Methods. This research adopts a literature-driven, systematic review and conceptual analysis strategy to understand the cognitive processes of gifted students within the artificial intelligence ecosystem. Rather than relying on empirical field data collection, the study is based on a structured examination of existing academic literature and the achievement of an intertextual comparative synthesis.

Data collection. During the literature review process, prestigious academic databases, both nationally and internationally recognized, were utilized. Accordingly, searches were conducted on Web of Science, Scopus, ERIC, Google Scholar, and JSTOR using the defined key concepts ("artificial intelligence", "gifted students", "habitus", "post-humanism", "extended mind", "digital capital"). For the literature search based in Turkey, DergiPark and TR Dizin databases were primarily used.

Specific selection criteria were used to determine which studies would be included in the review. Accordingly, only articles from peer-reviewed journals, academic book chapters, or indexed scientific publications were analyzed. As a temporal limitation, priority was given to recent studies produced within the last fifteen years. However, classic works that form the cornerstone of the field's theoretical foundation (Bourdieu, 2020; Clark & Chalmers, 1998; Latour, 2005) were integrated into the research scope without any chronological restrictions.

However, popular science publications that are not peer-reviewed articles, and studies not directly related to the research focus were excluded. These inclusion and exclusion criteria were designed to enhance the study's theoretical consistency and ensure the scientific legitimacy of the literature analyzed.

Data analysis technique. The collected literature data were analyzed using thematic analysis and intertextual comparison techniques; Bourdieu's habitus theory was reinterpreted through the conceptual lens of Actor-Network Theory and the Extended Mind Hypothesis. The main goal of this analytical process is to establish a distinct conceptual framework among different theoretical schools, thereby providing a solid theoretical foundation for the phenomenon of "hybrid cognitive habitus".

Procedure. In line with the aforementioned philosophical and theoretical model construction, this research is based not on a field-based empirical data-collection design but on an original intertextual analysis paradigm that integrates post-humanist philosophy, philosophy of mind, and the sociology of technology literature. The main problem addressed in the research is the semantic erosion of traditional "biologically based and isolated" conceptions of genius with the advent of the age of artificial intelligence. To fill this theoretical void, the research employs a dialectical, symmetrical synthesis model that seeks to transcend static theoretical boundaries.

Throughout the analytical process, Bourdieu's (1990, 2020) theories of Habitus and Cultural Capital, reflecting the carbon-based and anthropocentric nature of classical sociology, are juxtaposed with Latour's (2005) Actor-Network Theory (ANT), which includes silicon-based and non-human actors in the equation, and Clark and Chalmers' (1998)

Extended Mind Hypothesis, on a plane of methodological symmetry. The theoretical tensions that emerge between these approaches are resolved, yielding a unique intersection that can explain the profound experience gifted students have with artificial intelligence. All the sub-conceptual structures and theoretical perspectives examined in the study were selected and situated within a critical theoretical framework based on their potential to elevate the phenomenon of giftedness from a simple perception of "instrumental technology use" to "ontological hybridization".

Results. This research systematically analyzed national and international literature addressing the interaction between the artificial intelligence ecosystem and the cognitive processes of gifted students and reached three main sets of findings.

Firstly, it has been determined that gifted students do not use artificial intelligence tools solely at a "functional/instrumental" level, such as for doing homework or searching for information; rather, they are positioned as an extension of reasoning in complex problem-solving processes, i.e., a "cognitive prosthesis". This situation points to a structural integration where human cognition and algorithmic systems are intertwined.

Secondly, it was found that this integration transformed students' social aptitudes and worldviews, producing a unique "hybrid cognitive habitus" structure where emotions, intuition, and algorithmic thinking patterns merged. The findings indicate that in gifted individuals, habitus is now constructed not only by the social environment but also by technological interfaces.

Finally, it has been found that this new cognitive habitus disrupts traditional cultural capital patterns (language skills, encyclopedic knowledge, etc.) and replaces them with a form of "algorithmic capital" based on the ability to "manage big data and manipulate algorithms". This situation has been observed to create a risk of a new "digital cognitive elitism" and structural stratification in education between those who have access to this technology and habitus and those who do not.

Conceptual analyses. This section examines the symbiotic relationship between gifted students and artificial intelligence technologies from a sociological and philosophical perspective. In this context, the post-humanist transformation of intelligence, habitus, and intellectual capital is subjected to theoretical analysis that focuses on silicon-neuron hybridization. Rather than presenting empirical data, this study seeks to outline a conceptual and theoretical framework (a conceptual paper) to reposition the concept of giftedness within the rapidly transforming digital ecosystem.

From Bourdieu's habitus to post-humanist ontology. Bourdieu's concept of habitus refers to how humans internalize social structures and transform them into a grammar that produces action (Bourdieu, 1990; Wacquant, 2016). However, in the digital world, this grammar is being rewritten not only by class and cultural codes but also by algorithmic intelligence. The cognitive maps of gifted students, in this new relational plane established with artificial intelligence, go beyond the development of a digital habitus (Ignatow & Robinson, 2017) and shift into a post-humanist realm where humans and machines are an inseparable whole.

In this evolution from cultural capital to algorithmic capital, the knowledge, educational competencies, and language skills traditionally encompassed by cultural capital (Bourdieu, 1986) are being replaced by the ability to manipulate artificial intelligence and to make sense of big data. This, combined with the "new literacies" perspective discussed by Lankshear and Knobel (2011), shows that genius is no longer a personal possession but rather a positioning within technological networks. Examined within the context of Actor-Network Theory and the sociology of objects, it reveals, as Latour (2005) argues, that society comprises not only human actors but also non-human objects. The relationship that gifted students establish with artificial intelligence tools is a perfect example of this hybridity; here, artificial intelligence is not simply an assistant but an active partner shaping thought.

Finally, in the context of post-humanist subject determination and cognitive expansion,

post-humanism removes the individual from the center of the universe and positions them as a part of technological systems (Braidotti, 2013). The cognitive capacities of gifted individuals extend beyond biological patterns, as suggested by the "Expanded Mind" hypothesis, elevating the concept of "giftedness" to a cyborgian state of intellectual performance (Clark, 2010; Clark & Chalmers, 1998; Heersmink, 2015).

Silicon and neuron symbiosis: The "symbiotic genius" model and cognitive articulation. Traditional theories of giftedness favor treating intelligence as an internal "entity" confined to the human central nervous system (Terman, 1925; Gagné, 2004). However, the emergence of artificial intelligence as a cognitive prosthesis has pushed the boundaries of genius beyond the biological confines. (Kurzweil, 2005; Bostrom, 2014). This section proposes that intelligence is no longer a "state», but a constant "flow" between silicon-based algorithms and carbon-based neurons.

Cognitive externalization and prosthetic intelligence. Within this theoretical model, gifted students use artificial intelligence not merely as a computational tool but as an extension of working memory in complex problem-solving stages. Floridi's (2014, 2019) concept of "Inforgs" plays a significant role in explaining the ontological relationship these students establish with the digital ecosystem. At this point, transferring a portion of the cognitive load to the algorithm creates cognitive leverage, allowing the human mind to focus on higher-level strategic and creative tasks.

From collective intelligence to hybrid genius. While Lévy's (1997) "Collective Intelligence" theory focuses on human interactions within a network, in the current situation, these interactions have evolved into a form of "hybrid collaboration" between humans and artificial intelligence. The highly gifted individual has become not just someone who stores information but a bridge builder who can discern meaningful patterns within the massive datasets provided by artificial intelligence. This shifts the definition of genius from possessing knowledge to managing algorithmic probabilities (Siemens, 2005).

Algorithmic intuition and new epistemology. The symbiosis established with artificial intelligence transforms the way students access information from a mere data transfer into a process of technological subjectification. Viewed through the lens of Simondon's (2011) theory of 'individuation,' this interaction represents a dynamic whole in which the student and the technical object (AI) are not independent of each other, but rather mutually construct one another. The algorithmic intuition that emerges in this process is a new epistemological layer shaped by the machine's data processing and the refined transmission of the prediction to the human mind (Simondon, 2011; Stiegler, 1998; Verbeek, 2011).

Hybridized cognitive habitus and self-construction: The triangle of emotion, intuition, and algorithm. In gifted individuals, habitus is no longer merely a manifestation of the social environment but also a cognitive ecosystem shaped by technological interfaces. In this chapter, Bourdieu's conceptual tools are reinterpreted within the context of digital identity and self-construction processes.

Digital Dispositions and Cognitive Schemas. Habitus determines a person's predispositions to perceive and act in the world. In gifted students, this is intertwined with the universe of possibilities offered by artificial intelligence. As Reay (2004) states, habitus is fundamentally based on the principle of generating a strategy. In the symbiotic genius model, this strategy arises from the hybridization of the human mind's qualitative depth and the algorithm's quantitative breadth. As a reflection of symbiotic habitus, the gifted individual, when solving a problem, combines their own intuitive process with the data-driven predictions of artificial intelligence along a single path of reasoning, without distinguishing between them.

Self-construction in artificial intelligence: Cognitive prosthesis and algorithmic other. For gifted individuals, artificial intelligence, while a library, is also an algorithmic mirror in which self-identity is negotiated. In the context of Giddens' (2023) concept of 'reflexivity of self-identity', these individuals compare AI outputs with their own cognitive performance and

continuously update themselves by manipulating these outputs. This process constructs a post-humanist identity model articulated with technology, extending self-perception beyond biological boundaries (Giddens, 2023; Foucault et al., 1988; Turkle, 2005).

Algorithmic Habitus and Cultural Socialization

The shift of social interactions to digital platforms and AI-powered networks has changed the nature of cultural socialization. The social success of gifted students is no longer judged solely by their physical presence in academic circles but by how they manage their algorithmic capital in the digital realm (AI-powered production, coding, rapid learning modules) (Hargittai, 2010; Miller, 2011). This is a new form of social stratification where "cultural well-being" is directly linked to technological competence.

The sociological transformation of genius and ontological rupture: the transhuman intellectual class. This chapter examines why the traditional "gifted" classification is no longer valid and the nature of the "new cognitive elitism" that occupies the top positions in society.

Crossing the biological limit: post-humanist capacity. Traditional sociology defines genius as either a social label or a biological exception (Becker, 1963). However, the hybridization of neuronal capacity with algorithmic systems has taken intelligence to a non-anthropocentric dimension. As Braidotti (2019) states, humans are no longer a static category but have evolved into a relational process constantly negotiating with technology. Gifted students, as initiators of this process, are the first social class to extend their cognitive capacities beyond their biological capabilities.

Digital elitism and the new social stratification. Symbiotic genius entails a new cognitive hierarchy. The academic elite, which Bourdieu (1998) referred to as "State Nobles", is now being replaced by "Technological-Cognitive Elites" who can build a symbiotic bridge with artificial intelligence (Schwab, 2017; Lash, 2007). This transformation leads to the democratization of genius and the recoding of cultural capital through algorithmic competence. This situation risks turning the gap between individuals who lack access to technology and those with the power to develop this hybrid habitus into an ontological chasm, as the new dynamics of digital capitalism further deepen structural inequalities (Sadin, 2020; Srnicek, 2017; Zuboff, 2024).

Ontological rupture: Redefining the concept of "creativity". Historically, genius has been identified with the subject who creates something out of nothing or produces something through unique inspiration. However, within the hybrid habitus, creativity is the ability to select the most aesthetically or functionally optimal option from millions of possibilities scanned by artificial intelligence and to seal it with human meaning. This aligns with Heidegger's (1977) ideas on the "essence of technology", viewing technology as a force that frames the world (Gestell) (Heidegger 1977; Winner 2017): Technology is no longer a passive tool, but a new existential arena that surrounds the human mind, and within this enclosed space, genius/creativity reopens itself.

Discussion. The rise of the symbiotic genius model and the hybrid cognitive habitus embodied in gifted students is not merely a story of educational success or technological adaptation; it is also a dialectical battleground encompassing serious societal risks, structural ruptures, and philosophical contradictions.

The symbiotic relationship established with artificial intelligence requires a massive accumulation of socio-economic and cultural capital. Van Dijk's (2005) "digital deepening" process demonstrates that inequality is no longer limited to physical access to technology; it is linked to the cultural and systemic infrastructure that transforms that technology into a mental advantage, a fluid cognitive habitus. The divide that will emerge between gifted students who have access to this hybrid capital (algorithmic competencies, big data management) and those who lack it is not simply a difference in achievement, but a risk of ontological "cognitive ghettoization". In this context, Lupton (2020) and Ignatow and Robinson (2017) remind us that digital socialization spaces do not erase class codes

but rather reproduce them within more refined networks.

This structural inequality, when considered within the framework of Rawls' (1971) "theory of justice», points to a hierarchy in which equality of opportunity is most radically undermined. While the Rawlsian principle of justice mandates that social advantages be used to benefit the most disadvantaged, the use of silicon-based prosthetic intelligence further elevates the already biologically advantaged, gifted minority to an even more inaccessible position.

Furthermore, when considered at the macro level, this situation aligns with Sassen's (2014) paradigm of "exclusions". Sassen argues that global capitalism no longer merely exploits people but completely marginalizes them from the system. Platform capitalism, centered in the Global North and controlling artificial intelligence infrastructure and algorithmic ownership (Srnicek, 2017), integrates the highly talented minds of the Global South into its networks while simultaneously pushing large masses lacking the infrastructure to develop this hybrid habitus into "cognitive exclusion". Consequently, symbiotic genius risks ceasing to be a local educational phenomenon and becoming a new instrument of global capitalist accumulation and structural exclusion.

In the symbiosis established with artificial intelligence, the limits of "human originality" and free will are the most critical threshold of debate. Clark and Chalmers (1998), in their Extended Mind Hypothesis, argue that the boundaries of the mind extend beyond the skull, presenting this process as an optimistic cognitive collaboration. However, this externalization of the mind and, as Heersmink (2015) states, the fact that writing and code become constitutive elements of the mind make humans vulnerable to manipulation by algorithmic systems.

Han's (2017) "psychopolitics" analysis comes into play at this point: the neoliberal system now subjugates the subject not through external coercion, but by optimizing their own desires, cognitive processes, and self-construction mechanisms. The gifted student's "hybrid habitus" offers them seemingly limitless intellectual horizons and creative space; however, in the background, they are surrounded by what Sadin (2020) conceptualizes as the "tyranny of the code". While the student combines their decisions and intuitions with the datasets provided by artificial intelligence, they are actually trapped by the algorithm's rationality that dictates what is "best and most optimized".

This situation establishes a paradoxical relationship with the logic of "outsiders" discussed by Becker (1963) in his sociology of deviance. Historically, genius has been considered a form of deviance/creative revolution that goes beyond social norms, speaks from outside the system, and breaks the normative structure. However, the new cognitive elites, in symbiosis with artificial intelligence, exist in an ecosystem where every behavior and thought pattern is commodified through data mining, which Zuboff (2024) calls "surveillance capitalism". It becomes difficult for a "disruptive and revolutionary genius" capable of shaking the paradigm to emerge from a mind that is constantly optimized, predicted, and shaped by algorithms. In line with Stiegler's (1998) warning that technological prosthetics "cognitively proletarianize" humans, even when a gifted individual updates their self-identity with a Giddensian (2023) reflexivity, they are actually operating within the boundaries drawn by the "algorithmic other". As Winner (2017) emphasizes, artifacts have a politics; artificial intelligence is not a neutral tool, but a political agent that tames the character of genius and transforms it into an instrument of systemic efficiency.

The educational equivalent of the symbiotic genius model and the shifting cognitive dispositions is a state of complete institutional incompatibility and crisis. The current educational bureaucracy is built upon a taxonomy rooted in Terman's (1925) or Gagné's (2004) biologically deterministic, isolated, and measurable intelligence tests. Educational institutions still register and reward success based on carbon-based performance within the individual's skull. However, as indicated in Siemens' (2005) connectivism theory and

Lévy's (1997) collective intelligence model, in the digital age, knowledge and intellectual performance are now a dynamic flow between nodes and networks. When a gifted student makes artificial intelligence a co-founder of their work, traditional pedagogy tends to code this as "cheating" or "academic misconduct".

This institutional blindness justifies the radical critique in Illich's (1971) *Deschooling Society*. Illich argues that schools commodify human ability by institutionalizing it and stifling original learning practices. For a gifted student with a hybridized cognitive habitus, the walls and static curriculum patterns of the modern school function as shackles. This is because these students experience a new ontological reality, embodied in Braidotti's (2013, 2016) post-humanist critique, which removes humanity from the center of the universe and establishes symbiotic partnerships with non-human agents (artificial intelligence).

As Reay (2004) points out, habitus is not a static structure but a mechanism for producing a flexible strategy for survival in new areas. Unless education systems can keep pace with this flexibility, as Bourdieu (1998) demonstrates in his work "*The State Gentiles*", they will only serve to preserve the cultural capital patterns of the old world (Bourdieu, 1986) and leave the "algorithmic capital" of the new age in the hands of elitist ghettos. Therefore, pedagogy must construct a new pedagogical ontology that removes intelligence from the category of personal possession and regards it as an aesthetic and ethical performance of human-machine hybridization.

Conclusion. This study examined the relationship between gifted students and artificial intelligence not simply as the use of a tool, but as a symbiotic transformation that reshapes Bourdieu's concept of habitus. At this point, "genius" is no longer an isolated biological superiority, but a hybrid form of performance occurring within technological networks.

The "Symbiotic Genius" model, developed during the research, demonstrates that intelligence is no longer an individual possession but a fluid capital that flows between humans and algorithms. This hybridization of silicon and neurons has radically transformed not only the information-processing speed of the gifted student but also their perception of the world and their internal planning. This technological transformation of the cognitive habitus that emerged among these students represents one of the sharpest ruptures in the history of human thought, because the "thinking subject" now possesses an "expanded mind" structure that transcends its biological limitations.

One of the most important findings of the study is that "digital capital" and "algorithmic competence" are becoming a new class-dividing factor. Highly gifted individuals are ontologically separated from the rest of society by their capacity to develop this hybrid habitus. This lays the groundwork for the emergence of a "post-human" intellectual class, while simultaneously creating a new form of exclusion for traditional intelligences with limited access to this technology. Sociologically, this points to a future where merit systems will be reclassified based on technological articulation capacity rather than biological ability.

Adapting to a hybrid reality requires educational systems to mitigate the potentially disruptive effects of the sociological transformation of giftedness in the age of artificial intelligence while maximizing its educational and societal benefits. A key priority is the post-humanist transformation of the curriculum, whereby intelligence is no longer conceptualized solely as an individual attribute but as a distributed and relational capacity emerging through human–AI collaboration. Consequently, educational frameworks should adopt hybrid models of achievement that recognize and assess the quality of these collaborative cognitive processes. Equally important is the promotion of cognitive justice and equitable access to AI-enabled learning opportunities. Artificial intelligence should not function as a cognitive prosthesis available only to privileged groups; rather, all gifted students should have the opportunity to develop algorithmic habitus and AI-related competencies as a matter of educational equity. Finally, ethical guardianship must become a central component of gifted education. Beyond acquiring the technical skills necessary to use

AI systems effectively, gifted students should be equipped with critical digital literacy skills that enable them to evaluate algorithmic outputs, recognize embedded biases, and resist forms of algorithmic domination. Collectively, these measures can support a more equitable, reflective, and socially responsible integration of artificial intelligence into gifted education.

In conclusion, the symbiosis of silicon and neurons is not a choice, but an inevitable evolution of the digital age. The "Symbiotic Genius" model presented in this study is open to empirical testing in future research, supported by qualitative or mixed methods, through the daily practices of gifted students with artificial intelligence interfaces. The sociology literature should accept this hybrid reality not as a non-human anomaly, but as a new manifestation of human genius, and update its theoretical tools accordingly.

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Original Article

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Factors Influencing the Choice of Minor Additional Educational Programs

Abstract

Introduction. The study addresses students' decision-making in the selection of minor additional educational programs in higher education. Minor programs enhance academic flexibility, interdisciplinary learning, and professional development by allowing students to complement their primary field of study with additional knowledge and competencies aligned with their interests and career aspirations. However, the factors influencing students' choices of Minor programs remain insufficiently studied. *Methodology and Methods.* The study employed a quantitative research design based on an online survey aimed at examining students' perceptions, preferences, and factors influencing the selection of Minor courses. Particular attention was paid to course choice determinants, preferred areas of study, and sources of guidance. *Results.* The findings indicated that students primarily consider instructor expertise, future career opportunities, expected professional benefits, personal capabilities, and the desire to acquire new knowledge when choosing Minor courses. Experienced peers, family members, and official information sources were also found to influence students' decisions. *Scientific novelty.* The scientific novelty lies in identifying the key motivational, professional, and informational factors that determine students' selection of Minor programs. *Practical significance.* The results can be used to improve the design, promotion, and organization of Minor programs in higher education, strengthen student guidance mechanisms, and align Minor courses with students' needs and career expectations.

Keywords: higher education system, minor additional educational program, minor program, major program, quality of education, additional specialty.

Introduction. Currently, minor additional education programs are widely used in the higher education system in order to increase the professional competence of students. These programs offer students the opportunity to receive additional education in addition to their main specialty, thereby increasing their competitiveness in the labor market (Damron-Martinez et al., 2013). According to modern researchers, the first use of the terms "Major" and "Minor" appeared in 1877-78 on a second-year flight from Johns Hopkins University. In the statement, students were instructed to choose basic and additional courses from among subjects in six different departments, two of which had a high level of proficiency. The "Major" course is one that the candidate must take in any subject that he presents as one of the two main parts of his work; the "Minor" course must take place in every subject that is taken as a supplement (Payton, 1961).

At first, these terms were not widely accepted. In the Register of February 1878, the terms "basic academic subjects," "additional," and "similar subjects" were used when describing curricula in Greek and Latin. However, the curricula specifically referred to as "Major" courses and "Minor" courses were defined in French and German, Mathematics, Chemistry, Biology, and Physics. These subjects are often

described according to their content focus, while the expected weekly time commitment remains largely unspecified. Even before 1881, curricula or individual courses for the English language and historical and philosophical subjects had not been developed. In his third annual report (1878), President Daniel S. Gilman provided specific examples to illustrate the selection of students' major and minor courses, a practice that is corroborated by evidence published in the early issues of the Register magazine (Payton, 1961).

In many European countries, the formation of the European Higher Education space and the Bologna reforms have contributed to the market orientation of the higher education sector (Ministry of Science and Higher Education of the Republic of Kazakhstan, 2022). The Bologna Process provides Kazakhstan universities with additional educational programs (Minor) along with the main educational program (Major). Minor programs are interdisciplinary educational programs. Minor programs aim to meet the needs of the labor market, achieving skills and learning outcomes in several key specialties, professional areas, or areas of Education (Ministry of Science and Higher Education of the Republic of Kazakhstan, 2022). Due to the introduction of the Bologna reforms, the University of Applied Sciences in the Netherlands has restructured its traditional educational programs and developed undergraduate-level curricula that correspond to a professional bachelor's degree. This reform and marketing trend introduced the concept of "major-minor" (Van Deuren, 2012). In this system, the main (major) forms the largest part of the undergraduate program and consists of a compulsory curriculum. The additional specialty (minor) forms a minor part of the undergraduate program and can be chosen by students at their discretion. In terms of marketing, the choice of an additional specialty (minor) allows students to adapt to the undergraduate program to suit their personal goals and interests (Van Deuren, 2012).

Today, many higher education institutions are introducing additional minor education programs, providing students with the opportunity to receive additional education in accordance with their interests. This system is becoming especially popular among multidisciplinary specialties, as it creates conditions for students to acquire additional skills and knowledge along with the main one. In their research, Nielsen & Ulriksen (2025) describe how second-year students "pave the way" between institutional constraints and personal interests, emphasizing the role of counseling and schedule/consistency in the study of electives and secondary subjects. Within an elective-rich curriculum, major/minor selection is iterative: students probe courses, update beliefs about fit and outcomes, then adjust plans (Dalberg et al., 2024), which helps explain late switches into or away from optional minors when signals about ability or enjoyment change. Many employers also ensure that candidates have competence in several areas and are competitive in the labor market (Van Deuren, 2012).

As indicated above, Minor additional education programs contribute to the enhancement of students ' analytical thinking, creativity, and adaptability (Rugen, 1934). The main objective of the Minor program is to provide students with interdisciplinary education as a complement to the main major (Jacobsen et al., 2020). At the course level, fresh evidence using the Theory of Planned Behavior shows attitudes, subjective norms, and perceived control predicting enrollment into new/elective offerings-proximal drivers that often precede declaring a minor (Dahl et al., 2024). All countries of the world, including the Republic of Kazakhstan, attach special importance to the development of the education system. In March 2010, Kazakhstan officially joined the Bologna Declaration, becoming the 47th member of the European Higher Education space and the first country in Central Asia to be recognized as a full-fledged member of this space (Balmagambetova, 2019; Kozhakmet et al., 2013). During this period, significant changes took place in the areas of ensuring the quality of educational programs, internationalization of education, increasing the mobility of students and teaching staff, and improving the qualification system (Jia et al., 2019).

Since the adoption of the Bologna Declaration by the Republic of Kazakhstan in 2010, the Minor system has been introduced at Nazarbayev University (NU) for the first time. Nazarbayev University began to implement this system in the system of academic freedom and credit education, which allows students to choose additional subjects in addition to the main specialty (Nazarbayev University, n.d.). In 2019. At EKU, named after S. Amanzholov, a minor additional education program was introduced into the main educational programs, and students began to receive additional specialties. The implementation of the Minor Program, an important component of the new undergraduate education model, began in 2020 at Kostanay Regional University named after Akhmet Baitursynov (Mustafina, 2022). In 2021, the Eurasian National University named after L.N. Gumilyov (ENU) began to introduce the Minor additional education program, which can only be selected by undergraduate students (L. N. Gumilyov Eurasian National University, n.d.). Later, a Minor additional education program began to be introduced in other higher educational institutions of Kazakhstan.

However, despite the official existence of the Minor additional education program in priority universities of Kazakhstan, the possibility of selective implementation has not been systematically established. Before offering Minor courses to students, it is necessary to emphasize how important the courses offered are and identify the factors that influence them. The choice of a Minor additional education program is influenced by various factors that contribute to the personal and professional development of students. At the course level, fresh evidence using the Theory of Planned Behavior shows attitudes, subjective norms, and perceived control predicting enrollment into new/elective offerings-proximal drivers that often precede declaring a minor (Gamage & Dehideniya, 2025).

The purpose of the present research work is to identify the main factors influencing students' choice of Minor additional educational programs. By analyzing these factors, the study aims to gain a deeper understanding of students' learning motivation and to contribute to the improvement of university educational policy.

Research objectives:

– to identify the main factors affecting students' choice of Minor programs;

– to assess the influence of individuals and information sources, including parents, friends, students with Minor experience, and official websites;

– to identify the most popular profession-related Minor courses among students majoring in Biology and Chemistry-Biology;

– to analyse the attractiveness of Minor courses offered in general subject areas.

Materials and Methods. This study employed a quantitative survey research design to identify the factors influencing students' choice of Minor additional educational programs. The survey method was selected because it enables the systematic collection of information about students' perceptions, preferences, and decision-making processes related to Minor program selection. The study focused on examining the factors that influence students' choices, identifying the preferred Minor courses, and determining the sources of advice that affect students' decisions.

Participants. The participants were undergraduate students enrolled in the educational programs 6B01517 Biology and 6B01716 Chemistry-Biology at Korkyt Ata Kyzylorda University. A total of 191 students from different years of study participated in the research. The inclusion of students from various academic levels provided a broader understanding of students' attitudes toward Minor programs. Participation in the study was voluntary, and all respondents agreed to take part in the survey.

Data collection instrument. Data were collected using a structured online questionnaire developed on the basis of the study conducted by Van Deuren (2012), which examined variables influencing students' selection of Minor programs. The questionnaire consisted of 9 questions divided into two main sections. The first section included demographic and academic information, such as gender, year of study, educational program, grade point average, and the voluntariness of choosing the current field of study.

The second section focused on the main objectives of the research and included four thematic blocks. The first block examined factors influencing the choice of a Minor program, including personal interests, career prospects, logical connection with the Bachelor's program, content of educational materials, opportunity to gain practical experience, assessment methods, employment prospects, influence on future success, reputation of the Minor course, reputation of the department offering the course, professional level of teachers, academic workload, convenience of the schedule, location of classes, individual capabilities, desire to learn something new, and connection with other Minor courses.

The second block examined sources of advice and information in choosing Minor courses, including parents, friends, students who are also choosing Minor courses, students with real Minor experience, and the official Minor Catalog website. The third block focused on profession-related Minor courses for students of the educational programs Biology and Chemistry-Biology. These courses included Biotechnology, Genetic Engineering, Plant Selection, Phytopathology, Neurobiology, Plant Ecology, Parasitology, and Training on Biological Online Platforms. The fourth block examined students' preferences regarding Minor courses in general subject areas, including foreign languages except English, programming, artificial intelligence, cybersecurity, financial literacy, SMM, targeting, marketing, and creative arts such as singing, dancing, visual arts, composing, directing, writing, and sculpture.

Responses were measured using a seven-point Likert scale, where higher scores indicated a greater level of importance, influence, or preference. The survey was administered online using Google Forms. The questionnaire link was distributed electronically to students enrolled in the selected educational programs. Before participation, respondents were informed about the purpose of the study and the voluntary nature of their participation. The online format enabled efficient data collection and facilitated participation from students representing different academic years and educational programs. After the completion of data collection, all responses were reviewed and prepared for statistical analysis.

Data analysis technique. The collected data were analyzed using SPSS statistical software. Descriptive statistical procedures were employed to summarize participants' demographic characteristics and identify the factors affecting students' selection of Minor programs. Mean scores and standard deviations were calculated to evaluate students' preferences and perceptions. To assess the reliability and internal consistency of the questionnaire, Cronbach's alpha coefficients were calculated for each thematic dimension. The findings were interpreted in accordance with the objectives of the study and used to explain students' preferences, motivations, and decision-making processes regarding Minor additional educational programs.

Results. Students of the educational programs 6B01517 Biology and 6B01716 Chemistry-Biology of Korkyt Ata Kyzylorda University participated in the research. A total of 191 students took part in the study. Table 1 presents the main demographic and academic characteristics of the surveyed students.

Table 1

General characteristics of survey participants

Variable	Average value	Standard deviation	Min.	Max.
Gender (1= male, 2 = female)	1.19	0.40	1	2
Course (1-4 course intervals)	2.54	1.07	1	4
Educational program (1 = Biology, 2 = Chemistry-Biology)	1.31	0.46	1	2
GPA Level (1 = high, 3 = low)	1.85	0.46	1	3
Voluntary choice of profession (1 = yes, 2 = no)	1.13	0.34	1	2

Female students predominated in the sample, which corresponds to the general gender distribution in these educational programs, where approximately 80% of students are female. The mean value for gender was 1.19, indicating that about 81% of the participants were female and 19% were male. The standard deviation was 0.40, which shows variation in gender distribution; however, female students clearly represented the majority of respondents. The minimum and maximum values were 1 and 2, respectively, indicating that both male and female students were included in the study.

The average year of study of the participants was 2.54, meaning that most respondents were second- and third-year students. The standard deviation was 1.07, indicating a certain variation among students from different years of study. The minimum value was 1 and the maximum value was 4, confirming that students from the first to the fourth year were represented in the sample.

The majority of respondents studied in the Biology educational program, as indicated by the mean value of 1.31. The standard deviation was 0.46, showing that both educational programs were represented. The minimum and maximum values were 1 and 2, respectively, corresponding to Biology and Chemistry-Biology. The average GPA level was 1.85, indicating that students' academic performance was generally above average. The standard deviation was 0.46, which shows that the academic performance levels of the respondents were relatively similar. The minimum value was 1, and the maximum value was 3, meaning that students with high, medium, and low academic performance were included in the study.

Regarding the voluntary choice of profession, the mean value was 1.13. This result shows that the vast majority of students chose their profession voluntarily, which may indicate a high level of academic and professional motivation. The standard deviation was 0.34, demonstrating little variation in the respondents' answers. The minimum and maximum values were 1 and 2, respectively, indicating that although most students chose their profession voluntarily, some students did not.

To assess the internal homogeneity of the survey structure, Cronbach's Alpha (Cronbach's Alpha) coefficients were calculated on four main thematic blocks (Jia et al., 2019). This analysis aims to determine the internal consistency of each scale, that is, the stability in the responses of the respondents. All four scales of Cronbach's Alpha coefficients are in the range of 0.965–0.995. These indicators indicate a very high level of reliability. According to the scientific literature, values above 0.9 indicate a very high internal consistency of the scale (George & Mallery, 2024). Thus, the results presented in Table 2 show that the measuring instruments used in the study have a high level of reliability and are suitable for systematically measuring students' perceptions regarding the choice of Minor programs.

Table 2

General reliability analysis based on the survey results (Cronbach's Alpha ratio)

Department name	Number of variables	Kronbach Alpha
Factors affecting the choice of Minor	16	0.995
Influence of consultants	5	0.968
Minor courses related to the profession	8	0.978
Minor courses in general subjects	8	0.965

The choice of Minor additional education programs by students has a significant impact on their professional and personal development. In this decision-making process, students try to choose subjects that are compatible with their main educational program and meet their goals. Personal interests and values are widely recognized as key factors influencing students' decisions when selecting educational programs. However, students' limited decision-making experience can complicate this issue. In addition, the small amount of data on specific factors

influencing the choice of additional education programs in Minor indicates the need for a deeper study of this field. In order to identify factors influencing the choice of additional education programs in Minor, we experimented on the following research questions.

What are the most important factors that Minor takes into account when choosing an additional education program?

Table 3, presented in the results and analysis section, shows the average scores and standard deviations for the main factors that students consider important in choosing a Minor additional education program. According to the results of the study, the factors that most contribute to the choice of students are as follows: professional level of teachers - average score 5.97, standard deviation 1.68. The impact of the program on future success- average score 5.96, standard deviation 1.66. Development of individual capabilities and interest in acquiring new knowledge - average score 5.95.

These data show that the main focus of students when choosing Minor courses is professional development and future financial stability. In addition, their desire for self-development and the acquisition of new knowledge and skills also plays an important role. That is, students believe that it is important not only to focus on a specific profession but also to achieve comprehensive personal growth. In addition, factors such as "Opportunity to gain practical experience" (average score = 5.91) and "Assessment methods" (average score = 5.92) are also considered important. These indicators indicate that students in the course of their studies pay special attention not only to theoretical knowledge, but also to its consolidation through practice and the acquisition of specific practical skills. In addition, it is observed that a fair and understandable assessment system also plays an important role in their decision-making.

Although the minimum score (5.76) belongs to the "Personal interest compliance" factor, this figure is also quite high. This data shows that, in addition to professional development and future opportunities, personal interests and inclinations are also important for students. That is, when making a choice, students take into account not only the areas that are useful or in demand, but also their inner motivation and the areas that they like. In total, the average of all 16 factors considered in the study was higher than 5.7. These indicators clearly show that students do not rely on only one criterion when choosing Minor programs, but, on the contrary, adhere to a comprehensive, multifaceted approach. That is, they equally take into account several important aspects, such as academic quality, future professional opportunities, personal interest, and practical values.

These results (additional information is presented in Table 3) indicate that in the process of developing and improving Minor programs for universities, it is necessary to focus on the following important areas: taking into account the professional and practical interests of students; ensuring the qualification and quality of training of teachers; and monitoring the compliance of programs with the requirements of the labor market. Designed with these factors in mind, Minor programs can better meet students' needs, increase their learning motivation, and strengthen their readiness for future professional life, as reflected in Table 3.

Table 3

Average scores of factors affecting the choice of a Minor program

Factors	Average score	Standard deviation
Compliance with personal interest	5.76	1.80
Logical relationship with the Bachelor's program	5.83	1.79
Content of educational materials	5.85	1.72
Opportunity to gain practical experience	5.91	1.67
Assessment methods (exam, project, essay)	5.92	1.70
Opportunity to find a promising job	5.92	1.70

Influence on future success	5.96	1.66
General reputation of the Minor course	5.90	1.68
Department reputation	5.94	1.67
Professional level of teachers	5.97	1.68
Severity of training load	5.77	1.70
Convenience of the lesson schedule	5.90	1.76
Location of the lesson	5.91	1.74
Individual features	5.95	1.68
Desire to learn something new	5.95	1.75
Relationship with other Minor courses	5.92	1.70

Whose advice do students turn to when deciding on the choice of a Minor additional education program?

Table 4 clearly indicates who the students sought advice from when choosing Minor courses or which sources of information they trusted the most. Based on the results, the role of students with Minor experience as the greatest influencers is unique (average score = 5.98). This shows that because students have real experience, their advice is perceived as reliable and useful. The advice of such students is perceived as reliable and useful, since they provide information based on real practice, not theory. Parents and the Minor Catalog website (both 5.87) have also been praised as important sources of advice. And the influence of friends, although also significant, is relatively slightly lower (5.64). This means that students, when making decisions, pay attention not only to informal opinions, but also to official sources and advice from people with life experience, such as parents. The opinion of friends, although also important to a certain extent, is somewhat underestimated in comparison. This indicates that students tend to rely on informed and reliable sources rather than purely emotional opinions when making decisions. They approach the choice of Minor courses in a comprehensive way, considering both personal advice and official information. The influence of different sources of advice in the selection of Minor courses is presented in Table 4.

Table 4

Influence of consultants in the selection of Minor courses

Advice source	Average score	Standard deviation
Students with real Minor experience	5.98	1.54
Parents	5.87	1.62
Minor Catalog website	5.87	1.61
Students engaged in Minor selection	5.86	1.60
Friends	5.64	1.68

What is the type of course do you choose the most?

Table 5 presents the opinions and assessments of students studying in the direction of "Biology" and "Chemistry-Biology" regarding the choice of Minor courses. This data shows which courses students are most interested in and how important they consider those courses. The results of the study showed that the course that aroused the highest interest among students was "Teaching biological online platforms". This course was rated with an average score of 5.90, which means that the majority of students rated it at a high level. Such a high assessment indicates that the course meets modern educational methods, as well as its relevance for students who intend to work in the field of online education in the future. The course "Neurobiology", which was in second place, also received great interest

from students. Its average grade is 5.80. This figure indicates that today the demand for the field of Neuroscience is growing and students are striving to deepen their knowledge in this area. In addition, the courses "Parasitology", "Biotechnology" and "Genetic engineering" are also highly appreciated.

The positive assessment of these courses by students indicates that they are closely related to their future professional areas and research interests. In particular, biotechnology and genetic engineering attract the attention of students as fields that are at the forefront of modern biomedical research and innovation. Although the average price for the "Phytopathology" course is relatively slightly lower (5.47), this does not negate the fact that there is also interest in the course on the part of students. Such an assessment means that this course is relevant for a certain group of students, especially for those who have an interest in the study of plant diseases. In total, Table 5 shows that students in the process of choosing Minor courses are trying to combine them with future professional opportunities, research interests, and modern requirements of the industry.

Table 5

Selected Minor courses in the areas of "Biology" and "Chemistry-Biology"

Minor course	Average score	Standard deviation
Training biological online platforms	5.90	1.65
Neurobiology	5.80	1.70
Parasitology	5.73	1.72
Biotechnology	5.72	1.79
Ecology of plants	5.71	1.78
Genetic engineering	5.70	1.76
Plant selection	5.70	1.82
Phytopathology	5.47	1.86

Table 6 shows the grades of students for the offered Minor courses based on generalized subjects. These grades determine which areas students are most interested in and which areas they consider most important. According to these data, the financial literacy course received the highest score (average score – 6.00). This indicates the desire of students to acquire specific life skills that can be used directly in practical life, that is, to manage personal finances, accumulate, and invest. In addition, SMM and marketing, artificial intelligence, cyber security, and foreign language courses are also highly valued. Interest in these courses indicates a high demand for students to master modern digital skills and learn foreign languages.

Table 6

Students ' assessment for Minor courses in general subjects

Minor course	Average score	Standard deviation
Financial literacy	6.00	1.61
SMM, targeting, marketing	5.96	1.60
Artificial intelligence	5.90	1.65
Foreign language (except English)	5.83	1.69
Cyber security	5.82	1.63
Beautician	5.80	1.71
Artist (singer, dancer, artist, etc.)	5.62	1.78
Programmer	5.59	1.75

These areas coincide with the current requirements in the labor market and open the door to future professional opportunities. Courses and programming courses related to the field of art also did not go unnoticed by students. However, these areas are rated relatively lower compared to the courses mentioned above. This means that although they are areas of interest, the priority is slightly lower. In general, it can be seen that the priority directions of students in choosing Minor courses are based not only on professional knowledge and skills, but also on personal development, practical benefits, and personal interests.

Discussion. The results of the study confirm that Minor additional educational programs are an important component of modern higher education, as they provide students with opportunities to expand their academic trajectory, acquire interdisciplinary knowledge, and develop additional professional and personal competencies. Minor programs allow students to supplement their main educational program with knowledge and skills that correspond to their individual interests, future career plans, and the changing requirements of the labor market. This supports the view that Minor programs serve not only professional, but also broader educational purposes, contributing to students' personal development and academic flexibility (Tomlinson, 2018).

The findings of the present study show that students' choice of Minor programs is influenced by a combination of several factors rather than by one dominant criterion. The high average scores for all factors indicate that students approach the selection of Minor courses in a comprehensive way. They consider the professional level of teachers, future career opportunities, practical usefulness, personal capabilities, interest in acquiring new knowledge, and the general quality of the program. This suggests that students perceive Minor programs as an important tool for strengthening their professional competitiveness and preparing for future employment.

One of the most significant findings is that the professional level of teachers was rated as the most important factor in choosing a Minor program. This indicates that students attach great importance to the quality of teaching and the expertise of instructors. For them, the effectiveness of a Minor course depends not only on its title or content, but also on the competence, experience, and professional qualities of the teachers who deliver it. Therefore, universities should pay special attention to the selection of qualified teaching staff when designing and implementing Minor programs. The results also show that students highly value the influence of Minor programs on future success and employment opportunities. This demonstrates that students are career-oriented and expect Minor courses to provide knowledge and skills that can be useful in their future professional activities. In this regard, Minor programs can be considered as a strategic mechanism for connecting higher education with labor market needs. Similar conclusions were presented by Davis et al. (2017), who emphasized that Minor programs could help students build their own educational trajectory and receive broader and deeper training.

Another important aspect is the high evaluation of practical experience and assessment methods. Students' interest in gaining practical experience shows that they prefer courses that are not limited to theoretical knowledge, but also include practice-oriented tasks, projects, case studies, laboratory work, and other forms of active learning. This is especially important for students of Biology and Chemistry-Biology, because their future professional activity requires not only theoretical understanding, but also practical and research skills. At the same time, clear and fair assessment methods are also important, as they influence students' motivation and confidence in the educational process. The study also revealed that students rely most strongly on the advice of students with real Minor experience. This result shows that practical experience is perceived as one of the most reliable sources of information. Students who have already taken Minor courses can provide realistic feedback about course content, workload, teaching quality, assessment methods, and practical usefulness. Therefore, universities should consider developing peer-consulting mechanisms, student feedback sys-

tems, or Minor ambassador programs, where experienced students can help others make informed decisions.

Parents and the official Minor Catalog website were also identified as important sources of advice. This indicates that students use both personal and institutional sources of information when making educational decisions. The high role of the Minor Catalog website shows the importance of providing clear, complete, and accessible information about Minor programs. Such information should include course objectives, expected learning outcomes, teacher qualifications, workload, assessment methods, practical relevance, and possible career benefits. If the information is incomplete or unclear, students may experience difficulties in making a well-grounded choice.

The preferences of Biology and Chemistry-Biology students also deserve attention. The highest interest was shown in the course related to training on biological online platforms. This result reflects the growing importance of digital technologies in biological education. Future specialists and teachers in the field of biology need to master digital tools, online platforms, virtual laboratories, and modern educational technologies. Interest in neurobiology, biotechnology, genetic engineering, parasitology, and plant ecology also shows that students are attracted to modern, research-oriented, and practically significant areas of biological science. The results for general Minor courses show that students are also interested in universal and practical skills that go beyond their main educational program. Financial literacy received the highest score, which indicates students' desire to acquire knowledge that can be used in everyday life and future professional activities. High interest in SMM, marketing, artificial intelligence, cybersecurity, and foreign languages demonstrates that students understand the importance of digital, communicative, and entrepreneurial competencies. These findings suggest that Minor programs should include both profession-related and interdisciplinary courses that develop broader competencies.

The obtained results are consistent with the idea that students' educational choices are shaped by personal interests, values, future expectations, and available information. Personal values and interests play an important role in decision-making; however, limited experience may complicate students' choices. The present study confirms this position, as students rely not only on their own interests but also on advice from experienced students, parents, and official sources. Overall, the results indicated that the development of Minor programs should be based on students' needs, professional expectations, and labor market demands. Universities should pay attention to the quality of teaching, practical orientation of courses, clarity of assessment, accessibility of information, and the creation of effective guidance mechanisms. Minor programs designed with these factors in mind can increase students' motivation, support their professional development, and help them acquire additional competencies necessary for future career success. Thus, Minor additional educational programs can be considered an important educational tool that supports academic flexibility, interdisciplinary learning, and students' readiness for professional life. The findings of this study may be useful for improving the design, promotion, and implementation of Minor programs in higher education institutions.

Conclusion. This study was conducted to identify the main factors influencing students' choice of Minor additional educational programs. The results showed that the most significant factors affecting students' choices include the professional level of teachers, the influence of the program on future success, individual capabilities, and the desire to acquire new knowledge. The findings also revealed that, when making decisions, students often rely on the advice of students with real Minor experience, parents, and official information sources. Among the profession-related Minor courses, Training on Biological Online Platforms and Neurobiology attracted the highest level of student interest. In the category of general Minor courses, Financial Literacy received the highest evaluation. The analysis of the selected courses indicates their practical orientation, connection with labor market demands, and relevance to students' professional and personal

development. These results demonstrate that the effective planning and implementation of Minor programs in higher education institutions should take into account students' needs, interests, and future career expectations, as well as the requirements of the labor market. The findings of this study may serve as a practical basis for improving university educational policy and developing high-quality individual educational trajectories for students.

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Original Article

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The Impact of Neurogames on the Development of Creative Skills Among Preschool Group Children

Abstract

Introduction. This article provides a comprehensive examination of the impact of neurogames on the development of creative skills in children of the preschool preparatory group. Based on the interconnection between cognitive, emotional, and sensorimotor systems in children aged 5–6, the authors present neurogames as a scientifically grounded tool for activating creative potential. In the context of growing interest in preschool education methods that stimulate brain activity, enhance sensorimotor coordination, and develop imaginative thinking, the implementation of neurogames is viewed as a relevant pedagogical task. *Methodology and Methods.* The research was conducted in preschool institutions by adapting neurogames to organized educational activities such as "Speech Development", "Children's Literature", "Fundamentals of Mathematics," and "Introduction to the Surrounding World". The study applied various methods, including sensory integration, imagination and creative thinking exercises, the "Neuromatryoshka" method, the method for assessing emotional response, as well as correlation and regression analysis to evaluate the effectiveness of the neurogames. *Results.* The authors empirically confirmed the effectiveness of neurogames in expanding children's vocabulary, enhancing emotional responsiveness, and stimulating imagination and figurative thinking, achieving positive outcomes. Comparative and quantitative analyses demonstrated that neurogames have a comprehensive positive influence on the development of cognitive, sensorimotor, emotional-volitional, and creative components of activity. *Scientific novelty.* The results suggest that stimulating brain activity through neurogames is an effective means of fostering creative skills in preschool-aged children. *Practical Significance.* The presented research is a scientific-practical work aimed at modernizing the content of preschool education and integrating innovative neuropedagogical approaches into educational practice.

Keywords: neurogames, creative skills, preschool children, sensory integration, emotional regulation, figurative thinking, neuropedagogy.

Introduction. In response to societal demands, the intensification of interdisciplinary integration and socio-cultural changes are imposing new requirements on the modern education system. Particularly, from the preschool education stage, the development of children's creative potential has become one of the strategic priorities in the global educational landscape. In recent years, the potential of neuroscience, specifically neuropsychology, neurophysiology, neurobiology, cognitive neuroscience, neurolinguistics, neuro-education, and neurotechnologies, has garnered particular attention in the development of children's creative skills, with a focus on the application of neurogames. As a result of the convergence of neuroscience, brain function, learning and memory processes, emotional-volitional processes, and behavioral mechanisms are being studied in greater depth, leading to the

introduction of new scientific foundations into preschool education and upbringing practices. In this context, alongside traditional pedagogical approaches, there is a high potential for prioritizing neuroscience-based methods, including neurogames grounded in neurodidactics, in the process of developing preschool children's intellectual, emotional, and creative potential. The creative development of children aged 5-6 is characterized by the rapid growth of imagination, figurative thinking, and the ability to generate original ideas. At this stage, children actively explore their environment and can creatively recreate their experiences through play, drawing, sculpting, and dramatization. Neurogames, as tools that activate brain function, stimulate cognitive processes, and facilitate learning, have proven effective, with significant contributions from both classical and contemporary foreign and domestic scholars.

The Model Curriculum for Preschool Education and Training states that "The development of children's creative skills and research activities is carried out daily, taking into account their individual characteristics, through play, as well as activities such as drawing, sculpting, collage-making, construction, and music-based organized activities". In the Model Curriculum, the development of children's creative skills in the educational and upbringing process is implemented through neurogames, based on individual characteristics, such as finger exercises, visual-spatial tasks, and activities that involve imagining artistic images.

In his Address to the People, President K.K. Tokayev emphasized the need for special attention to the education sector, highlighting the importance of preschool education and the need to focus on the direction of children's learning and upbringing (Tokayev, 2024). This is because preschool education is considered a crucial area that contributes to the further development of the state. The Address clearly outlines the necessity of creating conditions for quality education and upbringing from an early age. Therefore, the content of teaching and upbringing in preschool institutions in our country requires the introduction of new effective innovations aimed at enhancing the harmonious development of children and improving the quality of their cognitive, communicative, and creative skills. One of the innovations actively entering the current preschool education process is neurogames.

Neurogames are exercises and game forms designed to coordinate cognitive, sensory, and motor systems, enhancing brain activity. In this regard, the aim of our research is to empirically determine the effectiveness of neurogames in developing preschool children's creative skills. The objective of the study is to assess the impact of the systematic use of neurogames on the development of creative skills in preschool children. Children's creativity began to be studied scientifically as a subject of psychological and pedagogical research in the early 20th century. One of the pioneers, Vygotsky (2004), in his work "Imagination and Creativity in Childhood", demonstrated that children's creative activity develops in a fundamentally different way from that of adults, with imagination, emotional responses, and the ability to imitate real life being its underlying foundations. Supporting Vygotsky's (2004) ideas, Piaget (2003) demonstrated in his work, Play, Dreams, and Imitation in Childhood, that creative thinking is closely related to the stages of children's cognitive development.

In his work, Luria (1966), who studied the connection between creativity and the brain, demonstrated that the coordinated interaction between the brain's motor areas and language centers directly influences children's cognitive abilities, including creative thinking. He emphasized the importance of fine motor skill exercises and rhythmic games, which involve bilateral hand movements, in enhancing these abilities. In his research, Elkonin (1999) examined the relationship between creativity and play, demonstrating that children represent real-life situations during role-playing activities. Through the construction of imaginative scenarios, freedom and imagination are cultivated, indicating that play involves active engagement in activities that contribute to developmental processes.

Research by scholars reveals that the development of children's creative skills is based

on the interconnectedness of their cognitive, emotional, and motor systems. Creative skills are developed through imagination, visualization, and role-playing, allowing the child to freely represent life experiences. Neurogames enhance this process by activating the brain's motor and language areas through neuro-exercises and rhythmic games. Thus, neurogames can be used as an effective neuroeducational tool for developing creative skills in preschool children. Sherry & Dibble (2009) studied the impact of games on brain development in early childhood education and demonstrated their role in promoting the renewal of neural connections. The authors stated that playing activities and specially organized cognitive tasks strengthen synaptic connections and contribute to the development of the biological foundations of children's creative thinking. Karabulut (2013) theoretically and practically concluded that children's cognitive abilities develop during the preschool period as a result of sensory, motor, and emotional experiences.

In the work of Alotaibi (2024), it was demonstrated that the effectiveness of play-based learning in preschool education is assessed through systematic reviews and meta-analysis methods. The study also proves that neurogames have a significant impact on cognitive development, social development, emotional development, motivation, and activity levels. Parker et al. (2022) explored the importance of incorporating play into children's learning. The concept of "learning through play" demonѲstrates its contribution to the development of children's cognitive, social, emotional, creative, and physical competencies. From the key characteristics of teaching provided by the authors, the principles considered in neurogames can be identified:

- joyful: the learning process should bring joy and pleasure to the child;
- meaningful: education must be connected to the child's life experience;
- interactive: children should engage in collaborative activities with both their peers and the educator;
- active: the child must actively participate in the learning process and not just be a passive observer;
- repetitive: the child should learn by correcting mistakes through repetition and trying again.

In the works of Ayres (2018), exercises based on sensory integration are identified as playing a crucial role in the development of children's cognitive and motor systems. Sensory experiences are characterized as «food for the brain», and the incorporation of movement and rhythmic elements into the learning process is advocated. This approach has been applied in neurogames designed to enhance children's attention, memory, and motor coordination. Satova et al. (2021) developed a set of tasks aimed at fostering children's creative thinking and proposed specific methodologies for stimulating imagination, fantasy, and figurative thinking. The methods suggested by the authors served as the foundation for designing neurogames aimed at enhancing children's creative skills. The «Neuro-Matryoshka» method proposed by Zapodoynikova (2023) demonstrates positive results in the impact of neurogames aimed at developing a child's fine motor skills, creativity, and figurative thinking. Through symmetrical imagery, movement repetition, and mirror exercises, the method promotes the harmonious development of both brain hemispheres, showing its effectiveness in enhancing these cognitive abilities.

In the research of Dabyltayeva (2024), effective ways of developing preschool children's creative skills through various forms of visual arts, music, and theatrical games are clearly described. According to the author, when such art-pedagogical approaches and play technologies that enhance children's imagination, figurative thinking, and emotional intelligence are harmoniously applied, they enable the child to actively participate in the learning process, increase motivation, and create conditions for creative activity. Semago & Semago (2004) proposed methods for assessing emotional intelligence and social adaptation, establishing pedagogical mechanisms for developing children's abilities to recognize, understand, and regulate emotions. The methods used in the study were employed as essential tools in developing a child's emotional-volitional stability, self-

regulation, and confidence. In this regard, it is important to note that when a child's creative activity is combined with physical movement in the learning process, different areas of the brain are activated simultaneously. This strengthens neural connections, and the development of creative skills enters an active process. Thus, neurogames enhance the neurophysiological and cognitive effectiveness of traditional methods, positively influencing the development of children's creative skills. Based on the scientific works analyzed above, the possibilities of neurogames have been identified as a means to strengthen the interconnection between children's cognitive, motor, and personal traits, and to effectively influence the development of their creative skills, in conjunction with traditional teaching methods (Table 1).

Table 1

Creative skills and their development through art pedagogy, games, and neurogames

Creative Skills	Art Pedagogy	Games	Neurogames
Imagination and Visualization	Visual Arts and Music	Role-playing Games	Visual-Spatial Exercises - Enhance spatial thinking and the ability to visualize.
Cognitive Functions	Content Visualization	Plot Logic	Attention, Memory, Comparison - Develop the ability to concentrate attention, short-term memory, and establish logical connections.
Movement and Motor Skills	Physical Movement, Theater	Dramatic Play	Simultaneous Bilateral Hand Coordination - Integrates the right and left hemispheres of the brain, improving motor coordination.
Emotional Perception	Musical Influence, Emotions	Role-playing Activities	Emotional Imitation (Facial Expressions, Voice) - Enhances the recognition and expression of emotions, fostering creativity.

The development of creative skills is closely linked to the active functioning of the child's brain structures. The table illustrates that the neurogames presented have a comprehensive impact on the key components of preschool children's creative skills, including imagination and visualization, cognitive interest, movement and motor skills, and emotional perception processes. According to research, these processes are carried out through the activity of the brain's structural and functional regions (Vygotsky, 2004; Piaget, 2003; Luria, 1966). Specifically, the frontal lobe is responsible for thinking, decision-making, behavior, and movement; the parietal lobe is involved in bodily sensations and spatial orientation; the temporal lobe handles hearing, speech comprehension, and memory; and the occipital lobe is responsible for vision, imagination, and visual imagery. Neurogames enhance cerebellar activity, coordinating children's movements, promoting balance, and developing fine motor skills.

The parts of the midbrain, the thalamus (which processes sensory information), and the hypothalamus (which regulates emotions) are activated through neurogames, contributing to the development of skills in the emotional-volitional domain (Ayres, 2018; Semago & Semago, 2004). The conclusions of scholars indicate that the comprehensive activation of various brain regions simultaneously promotes the development of a child's imagination and logical thinking, motor skills and emotions, attention, and language abilities, allowing for the full realization of their creative potential in the preschool period. Thus, neurogames, as a system of functional neuro-exercises, enhance the interconnection between different areas of the child's brain and contribute to the comprehensive activation of the neural system. Neurogames are distinguished as both an innovative approach to developing creative skills and a modern neuroeducational tool that revitalizes traditional methods. In this regard, we have attempted to highlight the

scholars who have outlined the key components and characteristics of developing preschool children's creative skills through neurogames in their research (Table 2).

Table 2

Scholars who have scientifically grounded the components and characteristics of developing preschool children's creative skills through neurogames

Component	Description	Scholars
Cognitive (Cognitive Basis)	Attention, memory, thinking, imagination, information processing	Vygotsky (2004), Piaget (2023), Ayres (2018), Karabulut (2013), Alotaibi (2024)
Sensory-Motor (Finger, Hand, Body Movements)	Coordination of movements, fine motor skills, and body flexibility	Luria (1966), Ayres (2018), Zapodoynikova (2023)
Emotional-Volitional	Understanding and regulating emotions, self-regulation, and confidence	Semago & Semago (2004), Alotaibi (2024)
Creative-Activity	Imagination, figurative thinking, unique ideas, creative freedom	Vygotsky (2004), Piaget (2023), Elkonin (1999), Satova, et al., (2021), Parker, et al., (2022)

Table 2 systematizes the impact of neurogames on the development of preschool children's creative skills across four key components (cognitive-cognitive foundation, sensorimotor, emotional-volitional, and creative-activity) and correlates each component with the works of leading domestic and foreign scholars who have conducted research in this field. Unlike traditional didactic games, neurogames are specifically designed to stimulate the functional activity of the brain. They are implemented through the integration of sensorimotor coordination, bilateral movements, attention regulation, emotional activation, and cognitive interaction. While didactic games are mainly aimed at knowledge acquisition and skill reinforcement, neurogames are based on neuropsychological and neuropedagogical principles that promote interhemispheric interaction, neuroplasticity, and cognitive-emotional development.

The purpose of this study is to empirically determine the effectiveness of neurogames in developing the creative skills of preschool preparatory group children aged 5–6. The study is aimed at investigating how systematically organized neurogame-based activities influence children's cognitive functions, imagination, emotional regulation, sensorimotor coordination, and creative activity within preschool educational settings. Furthermore, the research seeks to identify the relationship between neurogames and the enhancement of preschool children's creative potential through neuropedagogical approaches.

Materials and Methods. This study employed a quasi-experimental research design with control and experimental groups. The research was conducted over 24 months during the 2023–2025 academic years in preschool educational institutions located in Almaty, Kazakhstan. The quasi-experimental design was selected because the preschool groups were formed according to the existing institutional structure, and random individual assignment was not possible due to ethical and organizational considerations. The study consisted of three main stages: diagnostic stage, formative stage, and monitoring and evaluation stage. During the diagnostic stage, the initial level of preschool children's creative skills, cognitive functions, emotional stability, imagination, and motor coordination was assessed. In the formative stage, neurogames were systematically integrated into organized educational activities. Finally, during the monitoring stage, repeated diagnostic assessments were conducted to evaluate the effectiveness of the implemented neurogames.

Participants. The participants of the study included 103 preschool preparatory group

children aged 5-6 years from preschool institutions in Almaty city. Among them, 51 children participated in the experimental group; 52 children participated in the control group. The experimental group participated in organized educational activities integrated with neurogames, while the control group continued traditional preschool educational practices without neurogame intervention. All participants were involved with the informed consent of their parents and under the supervision of preschool administrators, psychologists, and educators in accordance with the ethical standards of the Ministry of Education and Science of the Republic of Kazakhstan.

Research Environment and Intervention Process. The neurogame-based intervention was integrated into organized preschool learning activities, including speech development, children's literature, fundamentals of mathematics, and introduction to the surrounding world. Neurogames were conducted three times per week, and each session lasted approximately 25 - 30 minutes. The intervention program was implemented systematically throughout the entire research period. The neurogames included: mirror exercises; rhythm coordination activities; bilateral hand coordination tasks; symmetrical drawing; visual-spatial exercises; emotional recognition games; sensory integration exercises. These activities were designed to stimulate cognitive, emotional, sensory-motor, and creative processes simultaneously.

Several scientifically grounded methods and diagnostic tools were used during the study:

1. Sensory Integration Method - The sensory integration approach developed by Ayres (2018) was used to improve children's visual-motor coordination, rhythm perception, attention, and motor activity. Exercises involving movement, rhythm, and ball coordination were integrated into neurogames.

2. "Neuro-Matryoshka" Method - The "Neuro-Matryoshka" method proposed by Zapodoynikova (2023) was used to develop bilateral coordination, fine motor skills, imagination, and figurative thinking through mirror activities and symmetrical visualization exercises.

3. Emotional Intelligence and Social Adaptation Assessment - The methodology developed by Semago & Semago (2004) was applied to assess emotional-volitional stability, emotional recognition, emotional regulation, and social adaptation skills among preschool children.

4. Creative Thinking and Imagination Tasks - A set of creative tasks developed by Satova et al. (2021) was used to evaluate children's imagination, figurative thinking, originality, and creative activity.

5. Observation and Questionnaires - Observation methods and questionnaires for teachers and parents were additionally used to assess behavioral changes, communication skills, and children's participation in creative activities during the intervention process.

Neurogames Applied in the Study. The following neurogames were systematically implemented during organized educational activities: "memory grid", "counting with the ball", "mirror exercise", "drawing with hands", "depicting emotions". Each neurogame targeted specific developmental indicators such as attention, memory, emotional regulation, creativity, movement coordination, and imaginative thinking. The collected data were analyzed using both descriptive and inferential statistical methods.

Data Analysis. The collected data were processed using descriptive and mathematical-statistical methods: percentage indicators, mean values, and standard deviation were calculated. Comparative Analysis. The initial and final results of the experimental and control groups were compared in order to determine the dynamics of the development of creative skills. Correlation Analysis. Correlation analysis was used to identify the relationship between neurogames and the cognitive, emotional, sensorimotor, and creative development components of children. Regression Analysis. Multiple regression analysis was applied to determine the impact of neurogames on cognitive development. Cognitive development indicators were taken as dependent variables, while the above-mentioned neurogames were considered independent variables. Student's t-test was used to determine the statistical significance of the differences between the

results of the experimental and control groups. As a result, the indicator t = 5.45, p = 0.0016 was obtained, which statistically confirmed the effectiveness of neurogames. The structure of the neurogames was developed based on the above-mentioned scientifically grounded methodological guidelines. The neurogames were designed to stimulate children's physical activity, visual-motor coordination, imagination, and creative thinking. The methods used to assess the level of children's creative skills, as well as indicators of cognitive and personal development and the effects of neurogames, are fully described (Table 3).

Table 3

Neurogames, methods, and their effects are used to develop preschool children's creative skills

Indicators of Creative Skill Development	Applied Methods	Applied Neurogames and Their Effects
Cognitive Functions (attention, memory, thinking, imagination)	Sensory integration method – visual-motor coordination, rhythm exercises, ball activities	"Memory Grid", "Counting with the Ball" – develop concentration and memory.
Sensorimotor Development (movement coordination, fine motor skills)	Sensory integration method – visual-motor coordination, rhythm exercises, ball activities	"Drawing with Hands" – develops motor skills and movement coordination.
Emotional-Volitional Domain (emotional stability, self-confidence)	Emotion recognition and regulation method – recognizing and regulating emotions through play and sensory experience	"Depicting Emotions" – enhances emotional regulation and self-confidence.
Creative Activity (imagination, figurative thinking, creative engagement)	Symmetrical visualization method – creative tasks for figurative thinking and symmetrical drawing	"Mirror", "Drawing Similar Images" – develop creative imagination and figurative thinking

At the end of the experiment, a repeated diagnostic assessment was conducted. The initial and final results were compared, and the impact of neurogames on the development of children's creative skills was identified. The indicators presented in this table facilitate a comprehensive evaluation of the child's developmental level and provide a systematic framework for monitoring the specific developmental domains influenced by neurogames.

Results. The research experiment was conducted within the framework of a flexible curriculum for preschool children, implemented through organized learning activities. Specifically, the development of children's creative skills was targeted through neurogames adapted to the types of organized learning activities, including "Speech Development", "Literature", "Basic Mathematical Concepts," and "Introduction to the Environment". In each type of organized learning activity, neuro-exercises and game elements were introduced to enhance children's cognitive, motor, emotional, and creative activity. For example, in the "Speech Development" section, exercises coordinated with movements were used to activate vocabulary; in the "Literature" activity, visual depictions were recreated to strengthen emotional impact; and in the "Mathematics" lesson, games involving rhythm, counting, and logical thinking development were applied. During the "Introduction to the Environment" activity, exercises aimed at enhancing children's observational skills and imaginative visualization were carried out. The integrated approach within the flexible curriculum significantly strengthened the children's learning activity, creative imagination, and attention stability in the experimental group.

In each type of organized learning activity, neuro-exercises and game elements were introduced to enhance children's cognitive, motor, emotional, and creative activity. For example, in the "Speech Development" section, exercises coordinated with movements were used to activate vocabulary; in the "Literature"

activity, visual depictions were recreated to strengthen emotional impact; and in the "Mathematics" lesson, games involving rhythm, counting, and logical thinking development were applied. During the "Introduction to the Environment" activity, exercises aimed at enhancing children's observational skills and imaginative visualization were carried out. The neurogames not only developed the children's creative skills but also increased their interest, creating a positive emotional atmosphere for the learning and upbringing process. The integrated approach within the flexible curriculum significantly strengthened the children's learning activity, creative imagination, and attention stability in the experimental group. Figure 1 visually presents the integration of neurogames into organized learning activities.

Figure 1

Neurogames used in organized learning activities for developing preschool children's creative skills and their effects

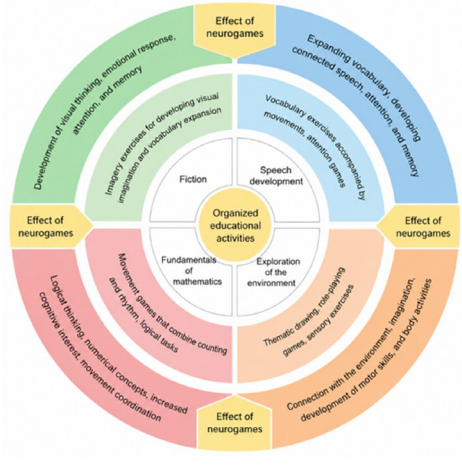


Figure 1 demonstrates the integration of neurogames into different types of organized learning activities for preschool children. The use of neurogames in speech development, literature, mathematics, and environmental education contributed to the activation of children's attention, imagination, motor coordination, and emotional development. The presented scheme illustrates the comprehensive impact of neurogames on preschool children's cognitive and creative activity. The systematic integration of neurogames into organized learning activities contributed to positive changes in preschool children's creative development. Based on the implemented neurogame activities presented in Figure 1, comparative statistical indicators of the control and experimental groups were obtained. Results of Preschool Children's Creative Skills Development Dynamics (Table 4).

Table 4

Comparative results of the impact of neurogames on preschool children's creative skills development and the growth dynamics of the experimental group indicators

Indicators	Initial Control Group (n=52)	Final Control Group (n=52)	Initial Experimental Group (n=51)	Final Experimental Group (n=51)	Growth Dynamics (Experimental)
Cognitive (Cognitive Basis) Functions	49%	57%	47%	65%	+18%
Sensory-Motor (Finger, Hand, Body Movements)	51%	59%	51%	67%	+16%
Emotional-Volitional, Orderliness	43%	57%	41%	66%	+25%
Creative Activity (Potential)	65%	78%	63%	87%	+24%

The table demonstrates that neurogames positively influenced all indicators of preschool children's creative development. An increase was observed in: cognitive functions; sensory-motor coordination; emotional-volitional stability; creative activity. The experimental group showed significantly higher growth dynamics compared to the control group. To further investigate the impact of neurogames on preschool children's creative skills, regression modeling was applied. Cognitive development (attention, memory, thinking, imagination) was considered the dependent variable, while the following neurogames were examined as independent variables: "memory grid"; "mirror"; "drawing with hands"; "counting with the ball"; "depicting emotions". Results of the Regression Analysis (Table 5).

Table 5

Multiple regression analysis of neurogames' impact on cognitive development

Variables	β	Std. Error	t	p
Memory Grid	0.52	0.11	4.72	0.001
Counting with the Ball	0.48	0.10	4.35	0.002
Mirror Exercise	0.31	0.09	3.11	0.004
Drawing with Hands	0.29	0.08	2.94	0.006
Depicting Emotions	0.27	0.07	2.75	0.009

$R^2 = 0.64$

Adjusted $R^2 = 0.61$

$F = 18.45$

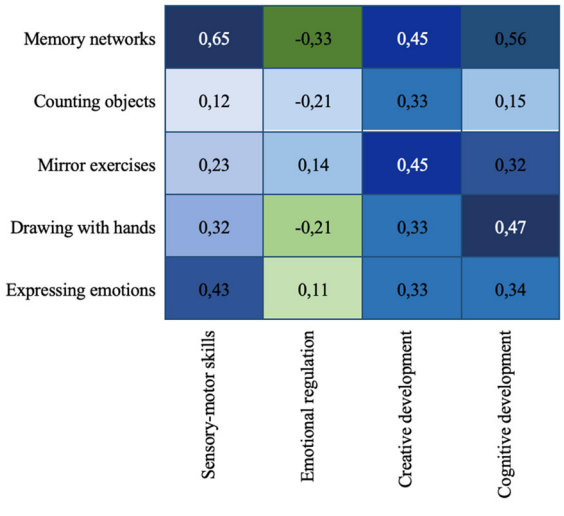
$p < 0.001$

The regression model demonstrated that the neurogames "Memory Grid" and "Counting with the Ball" had the strongest influence on the development of preschool children's cognitive functions. All predictors showed statistically significant effects ($p < 0.05$).

The results of the multiple regression model, the neurogames "Memory Grid" and "Counting with the Ball", which are aimed at improving attention concentration and memory, had the highest impact on developing cognitive functions (with a high β-coefficient, $p < 0.05$). Below, the research presents a correlation map that describes the effect of neurogames on preschool children's creative skills, shown through a diagram. Figure 2 presents the correlation map between neurogames and creative skill components

Figure 2

Correlation map describing the effect of neurogames on preschool children's creative skills



The diagram shows the correlation between the impact of neurogames (Memory Grid, Counting with the Ball, Mirror Exercise, Drawing with Hands, Depicting Emotions) and the key components of preschool children's creative skills (cognitive development, motor skills, emotional stability, and creative development):

- in the development of cognitive functions, the "Memory Grid" and "Counting with the Ball" games were found to have a significant impact on activating children's attention and memory processes;
- high correlation values in the development of sensory-motor skills and creative thinking were observed through the "Drawing with Hands" and "Mirror" games;
- the increase in emotional regulation levels was facilitated by the "Depicting Emotions" game, which contributed to enhancing the clarity of children's creative thinking and boosting their artistic freedom.

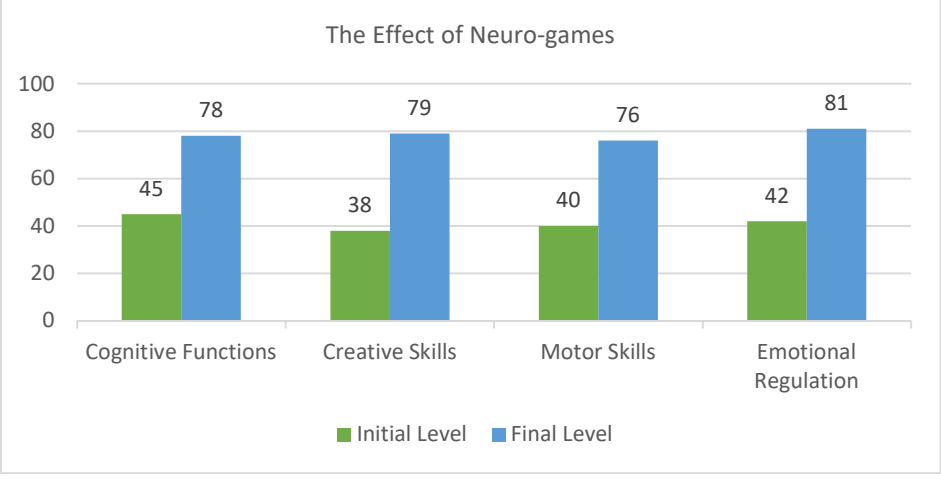
The intensity of the colors in the diagram and the correlation coefficients represent the level of interconnection between the neurogames and each component. Through the correlation map, it is evident that the systematic use of neurogames is effective in the comprehensive development of children's creative skills. As demonstrated above, the systematic use of neurogames led to positive changes in the development of preschool children's creative skills. However, to determine the specific impact of each type of neurogame on particular components, regression modeling was conducted. The analysis results presented below quantify this impact. The table shows that the neurogames had a positive impact on the development of preschool children across all indicators. The growth dynamics in the experimental group were identified based on the following indicators.

An 11% increase was observed in cognitive functions, which corresponds to the results of approximately 6 children out of 51. A 10% increase was recorded in sensory-motor skills, indicating an improvement in the development of approximately 6 children. There was also a 10% increase in emotional-volitional stability, which corresponds to 6 children. The highest growth was observed in creative potential, with a 16% increase, indicating a rise in the creative activity of approximately 9 children. In the control group, the learning and upbringing process conducted using traditional methods resulted in the following development indicators. An 8% increase was observed in cognitive functions, which corresponds to the results of approximately 4 children out of 52. An 8% increase was noted in sensory-motor skills, affecting approximately 4 children. A 14% increase was recorded in emotional-volitional stability, with the development of approximately 8 children improving. There was a 13% increase in creative activities, reflecting a rise in the number of creative activities of approximately 7 children.

The results of the control group showed that 27.0% (13 children) developed creative skills as a result of the natural developmental process and the impact of traditional methods. In contrast, the experimental group showed 43.7% (21 children), with a 16.7% difference. The targeted work based on neurogames in the experimental group yielded higher results, confirming the effectiveness of the experimental method. Overall, the changes in the control group reflect the impact of natural development and traditional methods; however, the growth in indicators is noticeably lower compared to the experimental group. The increase in each indicator confirms that the applied methods were purposefully directed and effectively organized. The results of the experiment were interpreted using quantitative and inferential statistical methods. The mean values, standard deviations, and percentage indicators of the development of creative skills in the control and experimental groups were compared and assessed. It was observed that the indicators of developed creative skills in the experimental group were significantly higher compared to the control group. The development of preschool children's creative skills is depicted through a radial diagram. Figure 3 illustrates the growth dynamics of preschool children's creative skills before and after the intervention.

Figure 3

The comprehensive impact of neurogames on the development of preschool children's creative skills



The research results demonstrate a clear positive change in the development dynamics of the key components of preschool children's creative skills. In the two-level radial diagram, the results of the initial and final levels for cognitive functions, motor skills, emotional-volitional stability, and creative potential are visually represented, showing the outcomes of systematically using neurogames. For example, cognitive functions increased from 47% to 65%, motor skills increased from 51% to 67%, emotional-volitional stability increased from 41% to 66%, and creative activity increased from 63% to 87%. In the diagram, the indicators for each component are presented in the format "X% → Y%" to illustrate the actual growth dynamics. The visualization not only displays the results but also provides a broader understanding of the scope of the neuroeducational approach's impact. Statistical analysis was performed using Student's t-test, which allowed for the assessment of the statistical significance of the difference between the mean results of the two independent groups (control and experimental). The analysis result: $t = 5.45$, $p = 0.0016$ ($p < 0.01$).

The identified indicator demonstrates that the growth in the experimental group is not due to chance and proves the effectiveness of the methodologies based on the neurogames used. Specifically, the p-value being below 0.01 indicates the statistical significance of the difference between the control and experimental groups. The average score for creative skills in the control group was 54.25%, with a standard deviation of 2.99, while in the experimental group, the scores were 65% and 2.58, respectively. Therefore, the results obtained demonstrate that neurogames have a comprehensive positive impact on the development of creative skills by actively engaging preschool children's cognitive, motor, emotional-volitional, and creative activities.

Discussion. The obtained results confirm the effectiveness of neurogames in developing preschool children's creative skills. The experimental group demonstrated significantly higher indicators of cognitive functions, emotional-volitional stability, sensory-motor coordination, and creative activity compared to the control group. The findings correspond with the studies of Choyak (2018), who emphasized the importance of sensory-motor and movement-based activities in stimulating brain functional activity and supporting children's cognitive and emotional development. The present study also supports neuroeducational approaches, suggesting that integrated movement and cognitive tasks positively influence preschool children's creative potential.

Neurogames contributed to the activation of cognitive, emotional, and motor processes through systematic engagement in movement-based, symmetrical, and emotionally oriented

exercises. The integration of attention regulation, emotional recognition, motor coordination, and imaginative tasks created favorable conditions for the comprehensive development of preschool children's creative skills. The correlation and regression analyses further demonstrated that neurogames had a statistically significant impact on children's cognitive and creative development. In particular, activities such as "Memory Grid" and "Counting with the Ball" showed the strongest influence on attention concentration, memory activation, and creative thinking development. Figure 1 presents a systematization of the neurogame elements used during the organized learning activities of "Speech Development", "Literature", "Basic Mathematical Concepts", and "Introduction to the Environment" in preschool groups. The exercises adapted for each organized learning activity were designed to activate children's cognitive, motor, emotional, and creative activities and to develop their creative skills.

The research results demonstrated the effectiveness of neurogames in developing preschool children's creative skills. The creative skill indicators of the experimental group children showed a significant improvement compared to the control group, indicating that neurogames had a comprehensive impact on the development of cognitive, sensory-motor, emotional-volitional, and creative-activity components. The systematic use of neurogames facilitated the active development of children's attention and memory, figurative thinking, emotional regulation, and the ability to transform imagination into creative activity. Additionally, the sensory integration methods, mirror exercises, emotion recognition, and symmetrical visualization exercises applied during the study helped unlock each child's creative potential. The development of creative skills was clearly evident as a result of the systematic use and repetition of neurogames, leading to the automation of activities. The development of preschool children's creative skills was reflected in the following characteristics:

1. Activation of Imagination and Figurative Thinking: Children began to freely create unfamiliar images and representations, inventing new roles and stories in narrative games.

2. Improvement in Sensory-Motor Coordination: Through mirror exercises and symmetrical drawing with both hands, the precision and coordination of the children's hand movements improved, demonstrating an increase in fine motor skills.

3. Establishment of Emotional Response: After exercises focused on emotion recognition, children were able to express their moods clearly through facial expressions and tone of voice. Additionally, their ability to understand the emotional states of their peers improved.

4. Strengthening of Attention and Memory Stability: During complex tasks, children were able to maintain focus, recall elements from previous exercises, and apply them independently in new situations.

5. Independence in Task Execution: As a result of repeating exercises during neurogames, children began to perform tasks independently without seeking assistance, demonstrating that the activity had become an automated skill.

The regression analysis conducted provides evidence of the impact of neurogames on the cognitive development component, demonstrating that their systematic use is an important tool in enhancing the creative potential of preschool children. To further investigate the impact of neurogames on preschool children's creative skills, regression modeling was applied. This model allows for the assessment of the effect of different types of neurogames on the level of cognitive development. Cognitive development (attention, memory, thinking, imagination) was considered the dependent variable, while the following neurogames were examined as independent variables: "Memory Grid", "Mirror", "Drawing with Hands", "Counting with the Ball", and "Depicting Emotions" games. The findings of this study demonstrate that neurogames significantly contribute to the development of preschool children's creative abilities, as reflected in improvements in cognitive functions, emotional-volitional stability, sensorimotor coordination, and creative activity. These results are consistent with the findings of Alotaibi

(2024), who reported that neurogame-based approaches positively influence children's cognitive, emotional, and social development. Similarly, the observed improvements in attention, memory, and coordination corroborate the conclusions of Ayres (2018), whose work on sensory integration highlighted the effectiveness of movement- and sensory-based activities in enhancing cognitive abilities. The gains in sensorimotor coordination found in the present study also support Luria's (1966) assertion that motor activity and cognitive development are closely interconnected and jointly contribute to higher-order thinking processes.

The findings further align with the work of Parker et al. (2022), who emphasized that effective learning occurs when activities are joyful, meaningful, interactive, active, and repetitive. The neurogames implemented in this study incorporated these characteristics, which may explain the substantial improvements observed in children's creative performance. In addition, the increase in creative activity and imaginative expression is similar to the results reported by Dabyltayeva (2024), who found that creative and engaging educational activities promote the development of children's creative potential. While previous studies primarily described the developmental benefits of neurogames and sensory-based approaches, the present study provides empirical evidence demonstrating statistically significant improvements across multiple developmental domains, thereby extending existing research on the role of neurogames in fostering preschool children's creativity.

Conclusion. The study aimed to determine the role of neurogames in the development of creative skills among preschool preparatory group children. In modern preschool education, particular attention is paid not only to children's academic readiness but also to the development of imagination, emotional stability, creative thinking, and the ability to express themselves freely. In this context, neurogames were considered an effective pedagogical tool that stimulates brain activity, increases cognitive interest, and creates opportunities for the development of children's creative potential. The results of the conducted research proved that neurogames are an effective tool for developing creative skills in preschool children. During the experimental work, the systematic use of neurogames had a positive impact on the development of children's cognitive, sensorimotor, emotional-volitional, and creative activity components. The obtained results demonstrated improvements in preschool children's attention, memory, figurative thinking, and creative activity.

The developmental indicators of the control and experimental groups were compared and analyzed. As a result, the experimental group demonstrated significantly higher developmental dynamics. Statistical analysis confirmed the effectiveness of the experimental methodology. The level of creative skill development among children in the experimental group was higher compared to that of the control group. The findings of the study showed that the use of neurogames in the preschool education and upbringing process contributes to the development of children's creative potential, stimulates brain activity, and enhances cognitive processes. The systematic implementation of neurogames makes it possible to improve the quality of organized learning activities in preschool institutions and supports children's creative abilities from an early age. Artificial intelligence tools were used only for technical editing purposes, including grammar correction, stylistic refinement, and improving the clarity of the text. The scientific content of the study, data analysis, interpretation of the results, and conclusions were entirely carried out by the authors.

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Original Article

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Digital Tools to Support Children with Special Educational Needs in Inclusive Education: A Mixed-Methods Study

Abstract

Introduction. Digital transformation in education creates new opportunities to support children with special educational needs (SEN/SEND) in inclusive classrooms, but the effectiveness of digital tools depends on purposeful pedagogical integration, accessibility, and collaboration with families. *Methodology and Methods.* A mixed-methods study (sequential explanatory design) with a quasi-experimental pretest–posttest non-equivalent groups design was conducted in inclusive primary school settings. Participants included 84 children with SEN, 24 educators, and 52 parents. The 12-week intervention implemented a structured toolset. Qualitative data were gathered via interviews and thematic analysis. *Results.* Compared with the comparison group, the experimental group demonstrated higher posttest outcomes, engagement, task completion, and independence. Teacher re-instruction time decreased more substantially. Subgroup gains were notable for AAC users and learners with reading/writing difficulties. Implementation fidelity was high; interviews highlighted improved accessibility and independence alongside infrastructure constraints. *Scientific novelty.* The study provides an evidence-based, school-embedded evaluation of a function-oriented digital support toolkit for SEN learners, combining effectiveness outcomes with implementation fidelity, teacher workload indicators, and home-independence data. *Practical significance.* Findings justify a scalable model for selecting and integrating digital tools by functional needs, embedding them into lesson structure and remedial support, and organizing teacher-specialist-parent collaboration to enhance participation, accessibility, and independence in inclusive education.

Keywords: inclusive education; special educational needs (SEN); assistive technology; digital tools; augmentative and alternative communication (AAC); Universal Design for Learning (UDL); primary school; learning engagement.

Introduction. In the context of the digital transformation of education, identifying effective tools to support children with special educational needs (SEN; also referred to as special educational needs and disabilities, SEND) has become increasingly important. Contemporary educational environments are progressively oriented toward inclusion, personalized learning, and equitable access to high-quality educational resources. However, in practice, children with SEN continue to face a range of barriers, including limited access to learning materials, insufficient adaptation of content and instructional approaches, a shortage of specialized pedagogical resources, and the limited readiness of educational organizations to systematically use digital technologies in remedial-developmental and instructional activities. Children with SEN include learners with diverse developmental and learning characteristics, such as hearing, vision, and speech impairments; musculoskeletal limitations; autism spectrum disorders; developmental delays; intellectual disabilities; learning difficulties; and emotional or behavioral challenges, among others. For

this group of learners, flexible formats of information presentation, alternative means of communication, visual support, step-by-step task organization, an adaptive learning pace, and continuous feedback are particularly important. When guided by sound pedagogical design, digital tools can provide these conditions.

Digital technologies in inclusive education encompass a broad range of solutions, including interactive learning platforms; augmentative and alternative communication (AAC) applications; software to develop speech and cognitive skills; screen-access and speech-synthesis tools; digital trainers and game-based learning environments; distance and blended learning platforms; progress monitoring tools; and artificial intelligence (AI)-enabled systems that adapt content to a child's individual capabilities. Their potential is not limited to improving the accessibility of learning materials; they can also enhance motivation, foster independence, expand communicative opportunities, and increase family involvement in the educational process. At the same time, integrating digital tools into the support of children with SEN is not automatically effective. The impact of digital tools depends on multiple factors, including the match between a tool and a learner's specific educational needs, teachers' methodological preparedness, the quality of digital content, parents' digital competence, the availability of technical infrastructure, and adherence to pedagogical ethics, data protection, and age-appropriate use. In some cases, digital means are used formally without considering a child's individual profile, which may reduce educational benefits and even increase cognitive overload.

Therefore, the scholarly significance of this topic lies in the need for a systematic analysis of which digital tools genuinely support the educational, remedial, and social development of children with SEN; under what conditions they are most effective; and which pedagogical models for their use are most productive in inclusive practice. The practical significance of the study is associated with developing recommendations for teachers, support specialists, and parents on the informed selection and use of digital solutions in education. At the policy level, the European Agency for Special Needs and Inclusive Education (2022) frames inclusive digital education as a system-wide agenda that requires accessible infrastructure, teacher capacity building, cross-sector coordination, and learner-centered design. The relevance of the topic is determined by: (a) the increasing number of children with SEN included in mainstream and inclusive education, which requires updated pedagogical approaches and support tools; (b) the digitalization of educational environments, which opens new opportunities for personalized learning but also reveals inequalities in access to high-quality digital resources; (c) the need for evidence-based practices for digital tools in inclusive education based not only on technological novelty but also on pedagogical effectiveness; (d) the need for an interdisciplinary approach that integrates pedagogy, special education, psychology, speech and language therapy, IT solutions, and accessible learning design; and (e) teachers' and parents' demand for concrete, methodologically grounded tools that can be applied in real-world practice.

This study aims to provide a theoretical rationale and analyse the potential of digital tools to support children with special educational needs, and to identify pedagogical conditions that ensure their effective use in the educational process. To achieve this aim, the following objectives were addressed: (1) to refine the concept and functional groups of digital tools used in work with children with SEN; (2) to identify pedagogical, psychological, and organizational foundations for their use; (3) to analyses the influence of digital tools on learning motivation, cognitive engagement, communication, and independence of learners with SEN; (4) to identify risks and limitations of digital support (technical, methodological, cognitive, and ethical); (5) to justify conditions for the effective integration of digital solutions in inclusive practice; and (6) to propose directions for improving digital support for children with SEN in schools and within psychological-pedagogical support systems.

Research question. Which digital tools, and under which pedagogical conditions, most

effectively support learning, communication, and development of children with special educational needs in an inclusive educational environment?

Hypothesis. The use of digital tools to support children with SEN will be pedagogically effective (reflected in increased engagement, improved accessibility of learning materials, higher-quality communication, and greater individualization of learning) provided that: (a) digital tools are selected about the child's functional profile and individual educational needs; (b) their use is integrated into lesson structure and remedial-developmental work rather than applied episodically; (c) teachers and support specialists possess methods for adapting digital content; (d) collaboration among teacher, specialist, and parent is ensured; and (e) principles of accessibility, appropriate dosing, safety, and pedagogical appropriateness are followed.

Materials and Methods. The study followed a mixed-methods approach with a predominantly quantitative component and subsequent qualitative clarification of findings (sequential explanatory design). This approach was selected because evaluating the effectiveness of digital tools for supporting children with special educational needs requires both the measurement of learning and behavioral indicators and the analysis of implementation conditions, barriers, and teachers' practices. Recent reviews in inclusive and digital education also emphasize the need to combine outcome data with implementation-process data (teacher training, infrastructure, accessibility, and organizational support) (Melo-López et al., 2025; Mukhtarkyzy et al., 2025). In addition, studies on learning analytics and intellectual/developmental disabilities underline the importance of addressing data-related barriers, accessibility of monitoring tools, and the ethical use of analytics when digital progress tracking is applied in inclusive settings (Conde & Rodríguez-Sedano, 2024).

The empirical design was quasi-experimental, including an experimental and a comparison group, with measurements before and after the intervention (pretest–posttest non-equivalent groups design). The intervention lasted 12 weeks and was implemented in inclusive primary school classrooms, consistent with international recommendations to evaluate digital solutions in natural educational environments rather than only in laboratory settings (UNESCO, 2023; OECD, 2025).

Participants. Participants included 84 children with SEN (aged 7–11 years; M = 8.9, SD = 1.2) enrolled in inclusive classrooms; 24 educators (primary teachers, special educators/defect ologists, and teacher assistants); and 52 parents (to provide additional assessments of home-based digital practices and the child's independence). The 24 educators were distributed equally between the study conditions: 12 educators supported the experimental classes and 12 educators supported the comparison classes. Each educator provided one aggregated teacher-level record for re-instruction time at pretest and posttest.

Children were allocated to two comparable groups: the experimental group (n = 42) received instruction with a structured set of digital support tools; the comparison group (n = 42) received standard support practices without systematic implementation of the digital toolset. Group formation was non-random and was carried out at the level of intact inclusive classroom clusters. Individual randomization of children was not applied because existing class composition, school timetables, parental consent procedures, and individual support plans did not allow reassignment of learners between classes. Experimental and comparison classes were matched before the intervention by age range, SEN profile distribution, baseline engagement, task completion, and availability of standard support; therefore, the design should be interpreted as a matched non-randomized quasi-experiment with non-equivalent groups.

The sample included children with a range of educational needs (including speech and language difficulties, autism spectrum disorders, reading/writing difficulties, ADHD, mild intellectual disabilities, and sensory limitations when appropriate accommodations were available). This decision was intentional: contemporary research suggests that digital

support in inclusive settings is most effectively analyzed through the lens of variability in needs and customization to the learner's profile rather than solely by diagnostic category (CAST, 2024; UNESCO, 2023). The intervention was based on the principles of accessibility, individualization, Universal Design for Learning (UDL), and pedagogical augmentation rather than technological replacement of the teacher. This aligns with the international agenda on digital inclusion, which emphasizes that technologies strengthen pedagogical practices rather than serve as stand-alone solutions for inclusion (UNESCO, 2023; WHO, 2024).

The following categories of tools were used:

1) augmentative and alternative communication (AAC): pictographic communicators; applications for symbol selection and speech output;

2) reading and writing support: text-to-speech; speech-to-text; apps with adaptive difficulty levels; visual highlighting; font and contrast adjustments;

3) organization and self-regulation: visual schedules; timers; step-by-step checklists; digital reminders and prompts;

4) interactive learning materials: multimodal tasks (text + audio + image); short interactive exercises with immediate feedback;

5) teacher tools: templates for adapting materials; digital monitoring of task completion; observation and progress logs.

The toolset was selected based on each child's functional needs and was agreed upon with the teacher and parent. This approach is consistent with evidence showing that assistive technologies are effective when individually configured and pedagogically integrated (Alsolami, 2022; Erdem, 2024; Pang et al., 2025). For learners on the autism spectrum, prior meta-analytic evidence on iPads/tablets has also shown positive academic effects, which supports the inclusion of structured tablet-mediated tasks when they are linked to individual learning goals (Aspiranti et al., 2020).

Data collection procedure. Data were collected in three stages:

Stage 1. Preparatory (2 weeks): obtaining informed parental consent; teacher briefing; initial assessment of the school's digital environment accessibility; individual tool configuration; pilot testing of observation protocols.

Stage 2. Main (12 weeks): regular use of digital tools during lessons (at least 3 times per week); weekly observation of learning activity and participation; data recording by teachers and the researcher; intermediate meetings with teachers (every 2 weeks) to check implementation fidelity (adherence to the intervention protocol).

Stage 3. Final (1 week): repeated measurements for all quantitative indicators; semi-structured interviews with teachers (n = 24); focus interviews with a subsample of parents (n = 16); collection of qualitative descriptions of successful and challenging cases. The 16 parents invited to the qualitative component were selected through purposive maximum-variation sampling from the total parent sample: 8 parents from the experimental group and 8 from the comparison group. Selection criteria included the child's age, type of SEN, baseline home-learning independence, and level of home digital-tool use. Interviewed and non-interviewed parents were compared by group membership, child age, SEN profile, and baseline parent-rated independence; no statistically significant differences were found (Fisher's exact test or Mann-Whitney U test, $p > .05$).

Data analysis technique. Measures included: learning engagement index (0–100), computed from an observational scale (attention to task, initiation of actions, completion of steps, response to feedback). The index consisted of four observable components scored from 0 to 25 points each; the total score ranged from 0 to 100. Internal consistency in the present sample was acceptable (Cronbach's alpha = .84), and inter-rater reliability for 25% of independently double-coded observations was ICC (2,1) = .81.

Task completion rate: proportion of learning tasks completed within the allocated time.

Independence index: number of steps completed without direct adult prompting during a standardized task. The indicator was based on a standardized eight-step learning task; 25% of sessions were independently coded by a

second observer, and inter-rater reliability was ICC (2,1) = .83. Communication participation: number of communicative initiatives per session (for children using AAC and/or requiring communication support). Teacher re-instruction time: minutes per lesson, based on teachers' time logs. Teacher logs were verified against weekly observation protocols; 20% of lessons were double-checked by the researcher, with inter-rater agreement of ICC (2,1) = .86 for logged re-instruction time. Parent-rated home learning independence: a five-item parent questionnaire rated on a 1-5 scale (1 = requires constant adult support; 5 = completes home-learning tasks independently); the mean item score was used in the analysis. Internal consistency was acceptable (Cronbach's alpha = .80), and parents were encouraged to add brief explanatory comments. Qualitative data: semi-structured teacher interviews; parent interviews; researcher field notes; observation protocols for cases of successful/difficult integration. Statistical analysis included descriptive statistics (M, SD, median, IQR); distribution normality checks (Shapiro–Wilk); baseline group comparisons (t-test/Mann–Whitney U); within-group pre–post comparisons (paired t-test/Wilcoxon); between-group comparisons controlling for baseline (ANCOVA); and effect size estimates (Cohen's d, r, partial η^2). The significance level was set at $p < .05$. Child outcomes were analyzed at the child level (n = 84), parent ratings at the parent-child dyad level (n = 52), and teacher re-instruction time at the educator level (n = 24; 12 educators per condition). For the teacher-level ANCOVA, baseline re-instruction time was entered as a covariate, which produced F (1, 21) degrees of freedom.

Qualitative data were analyzed using thematic analysis with iterative coding (open coding, grouping into categories, and theme development), and themes were checked for agreement between two coders. To enhance trustworthiness, expert code reconciliation and triangulation of qualitative themes with quantitative results were used, reflecting contemporary approaches to research on digital inclusion where both outcomes and implementation conditions matter (OECD, 2024; OECD, 2025). Inter-coder agreement for the initial coding matrix was satisfactory (Cohen's kappa = .78), after which discrepancies were discussed and resolved by consensus. The study was conducted in accordance with the principles of confidentiality, voluntary participation, and risk minimization. Personal data were anonymized. When using digital tools, accessibility of interfaces, acceptable screen-time duration, digital safety, and data protection were considered. The importance of these measures is supported by international guidance on technological inclusion and digital ethics in education (UNESCO, 2023; WHO & UNICEF, 2022).

Results. 1. Baseline comparability of the groups. At the pretest stage, no statistically significant differences were found between the experimental and comparison groups on key indicators ($p > .05$): learning engagement index, task completion rate, independence index, communication participation, and parent-rated home learning independence. This allowed for subsequent analyses of pre–post dynamics and between-group differences in posttest outcomes while controlling for baseline levels.

2. Change in learning engagement. In the experimental group, the mean learning engagement index increased from 54.8 (SD = 10.9) to 68.7 (SD = 11.6). In the comparison group, the index changed from 55.6 (SD = 11.2) to 59.8 (SD = 11.5). ANCOVA controlling for pretest scores indicated a statistically significant between-group difference in favor of the experimental group: $F(1, 81) = 18.42$, $p < .001$, partial $\eta^2 = .19$.

3. Task completion rate. In the experimental group, the proportion of tasks completed within the allocated time increased from 61.3% (SD = 14.5) to 78.9% (SD = 13.7). In the comparison group, the rate increased from 62.1% (SD = 15.1) to 67.2% (SD = 14.8). The between-group difference in posttest outcomes (controlling for pretest) was statistically significant: $F(1, 81) = 16.03$, $p < .001$, partial $\eta^2 = .17$.

4. Independence in task performance. The mean independence index (number of steps completed without direct adult prompting during a standardized task) increased from 4.1

(SD = 1.6) to 6.7 (SD = 1.8) in the experimental group, and from 4.3 (SD = 1.7) to 5.1 (SD = 1.9) in the comparison group. The between-group difference in posttest outcomes was statistically significant: $F(1, 81) = 14.27$, $p < .001$, partial $\eta^2 = .15$.

5. Subgroup analysis: communication support (AAC). For the subgroup of children using AAC tools (n = 18), the number of communicative initiatives per session was analyzed. In the experimental subgroup, the median increased from 2.0 to 6.0 initiatives; in the comparison subgroup, from 2.0 to 3.0 initiatives. The difference in gain between subgroups was statistically significant (Mann–Whitney U): $U = 23.5$, $p = .018$, $r = .48$.

6. Subgroup analysis: reading and writing support. For the subgroup of children with pronounced reading/writing difficulties (n = 24), reading speed (words per minute) and the percentage of correctly completed written tasks with digital support were assessed. Reading speed increased by +14.2 words/min in the experimental subgroup and by +5.1 words/min in the comparison subgroup ($p = .012$, $d = .72$). Accuracy of written tasks increased by +16.8 percentage points in the experimental subgroup and by +7.4 percentage points in the comparison subgroup ($p = .021$, $d = .64$).

7. Teacher re-instruction time. The mean time teachers spent on repeating instructions during a lesson decreased from 31.4 min (SD = 7.8) to 22.6 min (SD = 6.9) in the experimental group. In the comparison group, it changed from 30.8 min (SD = 8.1) to 28.9 min (SD = 7.7). The between-group difference in change over time was statistically significant: $F(1, 21) = 8.91$, $p = .007$, partial $\eta^2 = .29$. The unit of analysis for this indicator was the educator (12 in the experimental condition and 12 in the comparison condition), not the individual child; therefore, the analysis used teacher-level aggregated pre/post values.

8. Parent ratings of home learning independence. On the 1–5 scale, parent-rated independence in completing home learning tasks changed as follows: experimental group: 2.6 (SD = 0.7) -> 3.5 (SD = 0.8); comparison group: 2.7 (SD = 0.8) -> 3.0 (SD = 0.8). The between-group difference in posttest outcomes (controlling for pretest) was statistically significant: $F(1, 50) = 6.34$, $p = .015$, partial $\eta^2 = .11$.

Table 1

Main quantitative outcomes (pre/post) and between-group differences

Outcome	Exp pre M (SD)	Exp post M (SD)	Δ	Comp pre M (SD)	Comp post M (SD)	Δ	ANCOVA (F, p, partial η^2)
Learning engagement index (0–100)	54.8 (10.9)	68.7 (11.6)	+13.9	55.6 (11.2)	59.8 (11.5)	+4.2	$F(1,81) = 18.42$, $p < .001$, partial $\eta^2 = .19$
Task completion (%)	61.3 (14.5)	78.9 (13.7)	+17.6	62.1 (15.1)	67.2 (14.8)	+5.1	$F(1,81) = 16.03$, $p < .001$, partial $\eta^2 = .17$
Independence index (steps)	4.1 (1.6)	6.7 (1.8)	+2.6	4.3 (1.7)	5.1 (1.9)	+0.8	$F(1,81) = 14.27$, $p < .001$, partial $\eta^2 = .15$
Teacher re-instruction time (min/lesson)	31.4 (7.8)	22.6 (6.9)	-8.8	30.8 (8.1)	28.9 (7.7)	-1.9	$F(1,21) = 8.91$, $p = .007$, partial $\eta^2 = .29$
Parent-rated home learning independence (1–5)	2.6 (0.7)	3.5 (0.8)	+0.9	2.7 (0.8)	3.0 (0.8)	+0.3	$F(1,50) = 6.34$, $p = .015$, partial $\eta^2 = .11$

Table 2
Subgroup results

Subgroup/outcome	Experimental	Comparison	Statistics
AAC (n = 18): communicative initiatives per session (median)	2.0 -> 6.0	2.0 -> 3.0	U = 23.5, p = .018, r = .48
Reading/writing difficulties (n = 24): increase in reading speed (words/min)	+14.2	+5.1	p = .012, d = .72
Reading/writing difficulties (n = 24): increase in accuracy of written tasks (percentage points)	+16.8	+7.4	p = .021, d = .64

Table 3
Qualitative findings (theme frequencies) and protocol adherence

Theme (interviews)	Teacher mentions	Parent mentions
Improved accessibility of learning materials	31	18
Reduction in behavioral outbursts during transitions	22	-
Increased independence (visual prompts, timers)	27	21
Challenges sustaining tool use at home	-	19
Technical and organizational constraints	29	-

Note. Δ = change (post-test - pre-test). ANCOVA was performed, controlling for baseline (pre-test) scores. For teacher re-instruction time, ANCOVA was conducted at the educator level (n = 24; 12 per condition) with baseline teacher time as a covariate, resulting in F(1,21).

9. Qualitative findings. Thematic analysis of teacher and parent interviews identified recurring themes: improved accessibility of learning materials (mentioned 31 times by teachers and 18 times by parents); fewer behavioral outbursts during transitions between tasks (22 teacher mentions); increased child independence when using visual prompts and timers (27 teacher mentions; 21 parent mentions); challenges in sustaining tool use at home (19 parent mentions); and technical and organizational constraints (device shortages, unstable internet, limited preparation time) (29 teacher mentions).

10. Intervention fidelity. The mean implementation fidelity in the experimental group was 82% (range across classes: 71-91%). Fidelity was measured with a 12-item implementation checklist completed weekly by the researcher using classroom observations and teacher logs. The checklist covered frequency of digital tool use, match between selected tool and child's functional need, use of visual schedules/timers, AAC support where relevant, multimodal presentation of tasks, teacher monitoring, and adherence to the agreed lesson structure. Each item was scored as 0 = not implemented or 1 = implemented; the fidelity percentage was calculated as the proportion of planned protocol components completed across observed sessions. A second observer independently coded 25% of sessions, and inter-rater reliability was ICC (2,1) = .86. Most deviations were associated with device shortages on certain days, temporary teacher replacement, and unstable internet connectivity.

Discussion. The findings indicate that systematic use of digital tools in inclusive classrooms is associated with improved learning engagement, task completion, independence, and communication participation among children with SEN. The most pronounced effects were observed in subgroups where digital tools directly compensated for functional barriers: AAC for communication and text-to-speech/speech-to-text plus adaptive tasks for reading and writing. These results align with recent reviews and meta-analyses highlighting the potential of assistive technologies and multimodal digital solutions to increase participation, accessibility, and subjective

well-being of learners with disabilities and SEN (Mukhtarkyzy et al., 2025; Pang & Datu, 2025). From a practical standpoint, the results are important for several reasons. First, gains in engagement and task completion reflect not merely a 'technical effect' of device use, but the pedagogical value of a structured, visually supported, and adapted learning environment. This is consistent with UDL principles, which emphasize that effective learning environments should provide multiple means of representation, engagement, and expression (CAST, 2024). Second, the reduction in teacher re-instruction time suggests a potential redistribution of pedagogical resources: the digital environment (visual prompts, step-by-step instructions, timers) takes on part of routine explanations, allowing teachers to devote more time to targeted support. In contemporary discussions of AI and digital technologies in inclusion, this scenario is considered productive: technologies reduce routine workload without replacing pedagogical interaction (OECD, 2024; OECD, 2025; Melo-López et al., 2025). Third, qualitative data suggest that the sustainability of effects depends on implementation context: device availability, teachers' digital competence, family support, and organizational readiness of schools. This conclusion is consistent with studies indicating that, even when teachers view assistive technology positively, implementation is often constrained by insufficient training, limited time, and infrastructure gaps (Alsolami, 2022; Erdem, 2024).

Interpretation in the context of international approaches. The results can be situated within a broader international agenda where digital inclusion is understood not as merely providing hardware, but as a system of solutions including accessibility of interfaces and content, pedagogical strategies, organizational regulations, workforce development, ethics, and data security. UNESCO (2023) emphasizes that educational technologies should be evaluated in terms of relevance, equity, scalability, and sustainability, rather than solely by their availability, and points to a shortage of independent evidence for the effectiveness of many EdTech solutions, making studies in real school settings particularly important. Comparative OECD evidence further shows that digital equity and inclusion depend on a coordinated policy mix that combines access to devices and connectivity with accessibility standards, teacher preparation, data governance, and targeted support for vulnerable learner groups (Gottschalk & Weise, 2023). For children with SEN, these considerations are even more salient. WHO and UNICEF report persistent global inequalities in access to assistive technology, with barriers including cost, shortages of specialists, low awareness, and fragmented support systems. Therefore, even positive local school-based intervention results should be considered together with issues of accessibility and sustainable scaling (WHO & UNICEF, 2022; WHO, 2024). The field-level significance of the Global Report on Assistive Technology has also been emphasized by Smith (2022), who presents it as an important milestone for a new era of assistive technology provision.

Limitations. Despite statistically significant results, several limitations should be noted. (1) Quasi-experimental design: lack of randomization limits causal inference; external factors cannot be fully ruled out. (2) Relatively small sample: adequate for a pilot study, but restricts fine-grained analysis by SEN category and by tool type. (3) Heterogeneity of SEN profiles: reflects real inclusive practice but complicates identification of specific mechanisms of effect. (4) Limited intervention duration (12 weeks): allows assessment of short-term dynamics but not long-term sustainability. (5) Context dependence: findings were obtained in schools with a certain level of organizational readiness and may not generalize to other contexts. (6) Partial reliance on teacher and parent ratings: despite observation protocols and triangulation, some indicators (e.g., home independence) include subjective components. More specifically, groups were formed from intact classroom clusters rather than by individual random allocation; although baseline matching reduced initial group differences, this procedure does not eliminate all selection-related threats to internal validity.

Directions for future research. Promising directions include: longitudinal studies (6–12 months or longer) to assess sustainability of academic, behavioral, and socio-communicative effects; more rigorous experimental designs in school settings (cluster randomization; stepped-wedge designs); differentiated analysis by need profiles (e.g., ASD, dyslexia, speech disorders, sensory limitations) to match tools to profiles; research on implementation fidelity and cost-effectiveness to understand the best effect-to-cost models; assessment of digital accessibility and universal design of content as independent outcome factors; and studies involving AI tools focusing on transparency, teacher control, data protection, and prevention of digital inequality (OECD, 2024; OECD, 2025; Melo-López et al., 2025). Future design iterations should also include participatory design and living-lab models, particularly when developing educational technologies for autistic learners in mainstream primary schools (Ranzato et al., 2025).

Conclusion. This study showed that systematic implementation of digital tools in inclusive educational settings can be associated with improvements in key indicators of participation of children with SEN in the learning process, including higher engagement, greater independence, increased task completion, and expanded communicative activity. The most substantial results were observed when digital tools were selected according to the child's functional needs and integrated into pedagogical practice rather than used episodically. The findings confirm that the effectiveness of digital support depends not only on the type of tool but also on the quality of pedagogical guidance, teacher preparation, organizational readiness of the school, and family participation. This supports viewing digital tools as an important component of an inclusive ecosystem rather than an autonomous solution. The practical value of the study lies in proposing an empirically grounded model for school-based implementation of digital support tools for children with SEN, aligned with principles of accessibility, individualization, and UDL. At the same time, scaling such solutions requires further research and institutional support at the level of policy, infrastructure, and workforce development.

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Pedagogical Architecture of Dialogic Communication of Primary School Children with Emotional-Volitional Regulation: Experimental Verification

Abstract

Introduction. The article examines the formation of dialogic communication in primary school children with emotional-volitional dysregulation as an important condition for their socialization, learning activity, and overall development. The relevance of the study is determined by the close relationship between dialogic speech, emotional stability, self-regulation, and the child's ability to interact effectively with peers and adults. *Methodology and Methods.* The empirical study was conducted using the following diagnostic tools: "Diagnostics of Dialogic Speech in Primary School Children", "Communicative Activity of Primary School Children", and the "Protocol for Pedagogical Assessment of Children with ASD". To analyze the distribution of communicative activity levels across Grades 1–3, Pearson's χ^2 test was applied. *Results.* The results showed statistically significant differences in communicative activity levels among primary school children of different age groups. It was found that emotional-volitional dysregulation negatively affects the development of dialogic communication, behavioral regulation, and the child's ability to maintain productive interaction. *Scientific novelty.* The study substantiates the relationship between emotional-volitional difficulties and the level of dialogic communication development in primary school children. *Practical significance.* The obtained results can be used in the development of corrective, pedagogical, and psychological support programs aimed at improving communicative competence in children with emotional-volitional dysregulation.

Keywords: dialogic communication; primary school children; emotional-volitional dysregulation; communicative activity.

Introduction. One of the priority areas in the modernization of contemporary school education is the creation of conditions for the full inclusion of children with special educational needs in the educational environment and their successful socialization. The Law of the Republic of Kazakhstan dated July 11, 2002, №343 "On the Support of Children with Disabilities in Social and Medical-Pedagogical Correction" (as amended and supplemented as of June 26, 2021) establishes the legislative foundations for inclusive education (Law of the Republic of Kazakhstan №343, 2002).

In accordance with the State Compulsory Standard for Primary Education of the Republic of Kazakhstan, inclusive education is aimed at creating conditions to ensure equal access to learning for all students, considering their individual educational capabilities (State Compulsory Standard for Primary Education of the Republic of Kazakhstan, 2022). In particular, the emotional volitional characteristics of primary school children are a significant factor determining their psychological well-being. These characteristics have a direct impact on the development of dialogic communication

and the adequacy of communicative responses, making them critically important in assessing the development of speech competencies. Therefore, identifying the level of development of dialogic speech in the context of emotional-volitional manifestations is a necessary step before implementing corrective and developmental programs aimed at supporting effective dialogic communication in primary school children.

It is well established that innovative education for schoolchildren with emotional-volitional disorders (EVD) shifts the focus of the educational process from the mechanical acquisition of knowledge to the development of the internal "personal compass". In this context, the development of abilities for "social navigation" and harmonious interaction with others becomes particularly important. The issue of including primary school children with autism spectrum disorders (ASD), characterized by specific features of the emotional-volitional sphere, in the educational environment of mainstream schools remains of significant scientific and practical relevance. This problem consistently attracts the attention of researchers focused on identifying the conditions, mechanisms, and strategies for educating this category of children.

It is known that the emotional volitional characteristics of children with ASD serve as a system-forming factor that determines the specifics of communicative activity development, primarily dialogic communication. These considerations acquire particular significance in the context of special pedagogy, as the development of dialogic speech in children with emotional-volitional peculiarities is slow and requires targeted pedagogical support. Under these conditions, the formation of dialogic skills within a corrective and developmental environment becomes a "growth point", facilitating the development of communicative competence, self-regulation mechanisms, and successful social adaptation in primary school children. At the same time, contemporary psychological and pedagogical thought shifts the focus toward the socio-psychological determinants of the development of a child's emotional sphere. Studies by foreign authors (Egeland et al., 1993) demonstrate that a deficit of emotional contact creates a state of "emotional deprivation", distorting the attachment system and disrupting basic mechanisms of social interaction, which subsequently affects students' ability to engage dialogically within the communicative space of the educational environment (Egeland et al., 1993). From a corrective-pedagogical perspective, dialogic speech acquires the status of not only a means of communication but also a tool for personal development and socialization. Research demonstrates that the development of dialogic speech in primary school children is closely linked to their ability to establish contact, recognize the emotional states of others, and adequately express their own experiences (Belyaeva, 2009; Vaskivska et al., 2019). According to Aseeva (2016), these skills acquire the status of significant personal development, influencing the success of students' participation in verbal exchange processes. Studies emphasize the need to consider the characteristics of children with ASD when designing an inclusive environment (Lebedenko, 2018), whereas the pedagogical conditions for their emotional adaptation are also identified as a significant factor (Kedrovskaya, 2020).

Malyarchuk and Karasyov (2018) empirically confirm that the contextualization of emotional-volitional manifestations serves as a kind of "regulatory tuning", ensuring the full development of universal learning activities. Otherwise, as shown by Semago et al. (2020), the absence of systematic diagnostics and the neglect of emotional-volitional specifics lead to the development of communicative skills in a fragmented, «mosaic» manner, lacking internal coherence. In this context, the findings of Operto et al. (2021) complement the picture: a deficit in the regulatory alignment of these factors triggers a "chain reaction" of intensified emotional responses, which, in turn, destabilizes communicative processes and reduces their effectiveness.

Dialogic interaction, as a universal mechanism of development, provides the "framework" for the existence and structural organization

of any social system (Woodgate et al., 2020). In the educational environment, it functions as a "mediator of development", through which a student's cognitive, linguistic, and personal transformations are facilitated. At the same time, empathy - the ability to understand and share the feelings of others - is an integral part of meaningful dialogue (Merrells et al., 2018). Thus, despite the accumulated theoretical and empirical material, the issue of developing dialogic communication in primary school children with ASD, in the context of their emotional-volitional characteristics, remains insufficiently explored and requires experimental verification, which defines the focus of the present study.

Materials and Methods. In the framework of the present study, the researchers aimed to experimentally determine the developmental dynamics of dialogic communication in primary school children. The core diagnostic procedure was the method "Diagnostics of Dialogic Speech in Primary School Children" by Ignatyeva (2023), designed to assess the formation of key components of dialogic speech, including the understanding of utterances, the adequacy of responses, and the ability to maintain dialogic interaction. To obtain a comprehensive picture of communicative development, the following methods were used: The method "Communicative Activity of Primary School Children" by Venger and Solomatina (2014), which allows for the assessment of the interaction patterns of primary school children. The "Protocol for Pedagogical Assessment of Children with Autism Spectrum Disorders" by Khaustov et al. (2018), which enables the identification of specific features of communicative behavior and emotional-volitional regulation.

The combined use of the methods made it possible not only to determine the level of development of dialogic communication but also to experimentally substantiate the nature of the influence of emotional–volitional dysregulation on the development of dialogic communication in primary school children. The methodological foundation of the study is based on the communicative paradigm considered as a psychological mechanism for the socialization of primary school children (Ishankhankyzy et al., 2026). Research base: three (3) general education schools in Almaty (Nos. 85, 74, 172). The study involved 86 primary school children in Grades 1–3 with diagnosed emotional–volitional disorders.

Results. The initial (descriptive) experiment aimed to identify the level of development of dialogic communication in primary school children with emotional–volitional dysregulation. The method "Diagnostics of Dialogic Speech in Primary School Children" by Ignatyev (2023) is designed for a comprehensive assessment of the development of key components of dialogic speech in primary school children. It allows for the identification of the ability to engage in dialogue; initiative in verbal contact; the ability to ask questions; coherence and logical sequence of utterances; adequacy of emotional-verbal expressiveness; and the ability to maintain the proposed topic of conversation. Primary school children were given tasks such as initiating a dialogue with the experimenter, asking clarifying questions, composing a response to an address, completing or continuing an unfinished dialogue, and constructing a short dialogue based on a story picture. Assessment was conducted across three levels: high, medium, and low (Table 1, Figure 1).

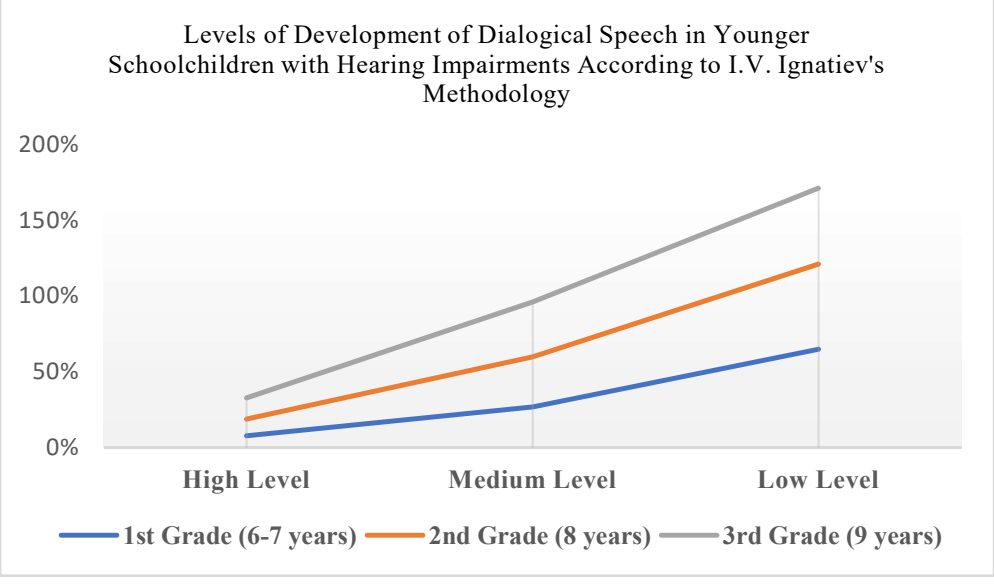
Table 1

Levels of development of dialogic speech according to Ignatyev's (2023) method

Age / Grade	Number of Children	High Level	Medium Level	Low Level	M	SD
1st Grade (6-7 years)	26	8 %	27 %	65 %	1,43	0,62
2nd Grade (8 years)	28	11 %	33 %	56 %	1,55	0,59
3rd Grade (9 years)	32	14 %	36 %	50 %	1,64	0,57
Total	86	11 %	32 %	57 %	1,54	0,59

Figure 1

Initial levels of dialogic speech development in primary school children with emotional-volitional disorders (descriptive stage)



As can be seen from Table 1 and Figure 1, the low level is predominant (50-65%), at which primary school children demonstrate one-word responses, difficulties in initiating dialogue, agrammatism, underdeveloped question constructions, and frequent lapses in logical coherence. Primary school children with emotional-volitional disorders at the medium level (27-36%) were characterized by situational activity, occasional coherent statements, difficulties in maintaining the topic, and weak emotional expressiveness. At the high level (8-14%), primary school children with emotional-volitional disorders can initiate dialogue, use logically organized sentences, ask appropriate questions, and demonstrate emotional–verbal expressiveness.

It should be noted that improvements are observed with age: an increase in the medium level by 9%, a decrease in the low level by 15%, and a growth in the high level by 6%. However, the overall dynamics remain weak, indicating the need for pedagogical intervention. The majority of primary school children with emotional volitional disorders demonstrate a low level of dialogic speech. The most pronounced difficulties are related to initiative, coherence, and maintaining the topic. In children with primary-type ASD, these impairments are more pronounced. The age-related dynamics are positive but insufficient for independent compensation. These results confirm the need to develop and implement a pedagogical approach. After analyzing the structural components of dialogic speech using Ignatyev's (2023) method, it became necessary to clarify the extent to which primary school children with emotional volitional disorders can perform communicative functions in conditions of joint activity. For this purpose, the method "Communicative Activity of Primary School Children" (Venger & Solomatina, 2014) was used at the next stage. This method allows for the assessment of initiative, the ability to interact within a group, communicative strategies, social flexibility, and emotional responsiveness. It enables evaluation of a child's real capacity to engage in interaction, assume social roles, demonstrate initiative, and construct cooperative forms of communication, which are essential for the development of full-fledged dialogue. The method focuses on studying the structure of a child's communicative activity in both organized and spontaneous interactions. The criteria for assessing the development of communicative behavior in primary school children were defined by the following indicators and levels (Table 2).

Table 2

Criteria and levels of development of communicative behavior in primary school children with emotional-volitional disorders

Indicator	High Level (Initiative–Adaptive)	Medium Level (Situational–Reactive)	Low Level (Fragmented–Restricted)
Communicative Initiative	Independently initiates contact, proposes topics, asks questions, and actively main_ tains the dialogue	Shows initiative episodically, more often responds to prompts, and struggles to develop the topic.	Avoids initiating contact, engages in interaction only when prompted, or does not engage at all
Social Selectivity in Communication	Demonstrates flexibility in interactions with classmates and teachers	Prefers communication with teachers and selectively with classmates	Avoids contact or shows pronounced selectivity, social isolation
Ability for Collaborative Activity	Actively engages in group activities, distributes roles, cooperates, and contributes to the overall outcome.	Participates in the group with support, performs individual functions, and interaction is unstable	Does not engage in collaborative activity, cannot maintain a role, avoids or disrupts interaction.
Social Flexibility	Easily adapts behavior to the situation, considers others' interests, and modifies communication strategy.	Shows partial flexibility, adaptation is slow or incomplete	Rigid behavior does not consider the context of communication, and difficulty switching
Emotional Responsiveness	Recognizes and considers others' emotions, demonstrates empathy, and adequately expresses own feelings	Partially recognizes emotions, responds selectively, and shows limited emotional expressiveness.	Does not consider others' emotional states; empathy is reduced or absent.
Communicative Strategies	Uses appropriate communicative strategies (requesting, explaining, reasoning)	Has a limited repertoire of strategies; use is not always appropriate to the situation	Uses inappropriate forms (ignoring, protesting, stereotypical responses)

Based on the previously identified difficulties (low initiative, weak regulation, limited cooperation), the data are as follows (Table 3, Figure 2).

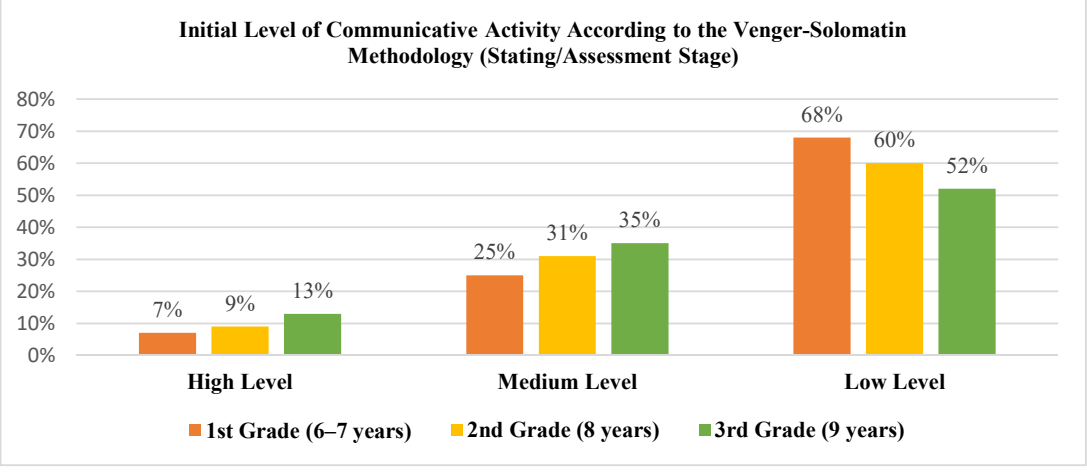
Table 3

Initial Level of Communicative Activity in Primary School Children with Emotional-Volitional Disorders (Venger–Solomatina Method)

Age / Grade	Number of Children	High Level	Medium Level	Low Level	M	SD
1st Grade (6–7 years)	26	7 %	25 %	68 %	1.39	0.61
2nd Grade (8 years)	28	9 %	31 %	60 %	1.49	0.58
3rd Grade (9 years)	32	13 %	35 %	52 %	1.61	0.56
Total	86	10 %	30 %	60 %	1.50	0.58

Figure 2

Initial Level of Communicative Activity According to the Venger–Solomatina Method (Descriptive Experiment)



To analyze the distribution of communicative activity levels across the three age groups, Pearson's χ^2 test was used, $\chi^2 = 10.72$, $p < 0.01$, indicating statistically significant differences between Grades 1–3. Additionally, an analysis of mean values showed an increase in M from 1.39 to 1.61 points and a decrease in SD from 0.61 to 0.56, confirming a gradual leveling of communicative skills with age, although functioning remained at a low level. The results indicate that the low level (fragmented–restricted) predominates across all grades (52–68%). This is manifested in difficulties establishing contact, avoidance of interaction, weak engagement in collaborative activities, frequent use of gestures and one-word responses, and low emotional responsiveness. The medium level (situational–reactive) increases with age (25 → 31 → 35%), reflecting partial development of certain communication components. The high level (initiative–adaptive) occurs rarely (7–13%). Children at this level are capable of taking initiative, working in a group, flexibly adjusting their behavioral strategies, and expressing emotional involvement.

Children with primary-type ASD consistently fall within the low level, which aligns with the observations and data of Ignatyev (2023). Overall, the findings show that the communicative activity of primary school children with emotional volitional disorders at the descriptive stage is characterized by a predominance of low-level development (60%). Statistically significant differences between grades ($\chi^2 = 10.72$; $p < 0.01$) confirm age-related dynamics; however, the intensity of this progression is insufficient for the spontaneous compensation of communicative deficits. These data highlight the need for targeted pedagogical interventions aimed at developing initiative, social interaction, and emotional responsiveness.

The data obtained using the method of Venger and Solomatina (2014) allowed us to identify general features of communicative activity in primary school children with emotional-volitional disorders, including pronounced difficulties in initiating interaction, social rigidity, and low engagement in collaborative activities. However, for a comprehensive understanding of the structure of these impairments and to determine the specifics of communicative behavior in children with emotional–volitional disorders, particularly in the subgroup of students with primary-type autism spectrum disorders, more detailed diagnostics were required. Accordingly, the next stage of the descriptive experiment involved the use of the "Protocol for Pedagogical Assessment of Children with ASD" (Khaustov et al., 2018), adapted for primary school children with emotional–volitional disorders. This method allows for the assessment of behavioral, communicative, and emotional–regulatory characteristics

that are not captured by traditional speech diagnostic tools, serving as a crucial instrument for refining the child's profile and planning subsequent formative interventions. To clarify the structure of impairments in dialogic speech and communicative activity in children with emotional-volitional disorders, including the subgroup of students with primary-type ASD, the "Protocol for Pedagogical Assessment of Children with ASD" (Khaustov et al., 2018) was employed. The protocol was adapted for school-age children and supplemented with items to evaluate features such as behavioral regulation, emotional responsiveness, communicative initiative, social interaction, use of alternative means of communication, and the ability to engage in collaborative activities. This method enables the documentation of the behavioral and speech profile of primary school children, representing a critical step in developing an individualized corrective intervention plan.

Assessed Parameters of the Adapted Protocol: Contact and Ways of Establishing Contact; the child's ability to initiate and maintain interaction; Response to Address and Instructions; how the child reacts to verbal prompts and guidance; Communicative Initiative; the child's tendency to take the lead in interactions. Use of Alternative Means of Communication gestures, facial expressions, pointing, or other nonverbal methods; Emotional Expressiveness and Responsiveness of the child's ability to recognize, express, and respond to emotions; Attention Shifting and Behavioral Regulation flexibility in focus and self-regulation of actions; Degree of Engagement in Group Activities participation in collaborative tasks; Maintenance of the Topic in Joint Activities ability to stay on topic during shared tasks; Features of Motor and Sensory Behavior assessed using Khaustov et al. (2018) scale; Manifestations of Stereotypies / Ritualized Actions repetitive or ritualized behaviors. All parameters were assessed by teachers and psychologists using a three-point scale: 0 (absent), 1 (moderately expressed), 2 (strongly expressed). At the descriptive stage, the data were converted into a level-based system: high/medium/low level of communicative behavior development (Table 4 and Figure 3).

Table 4

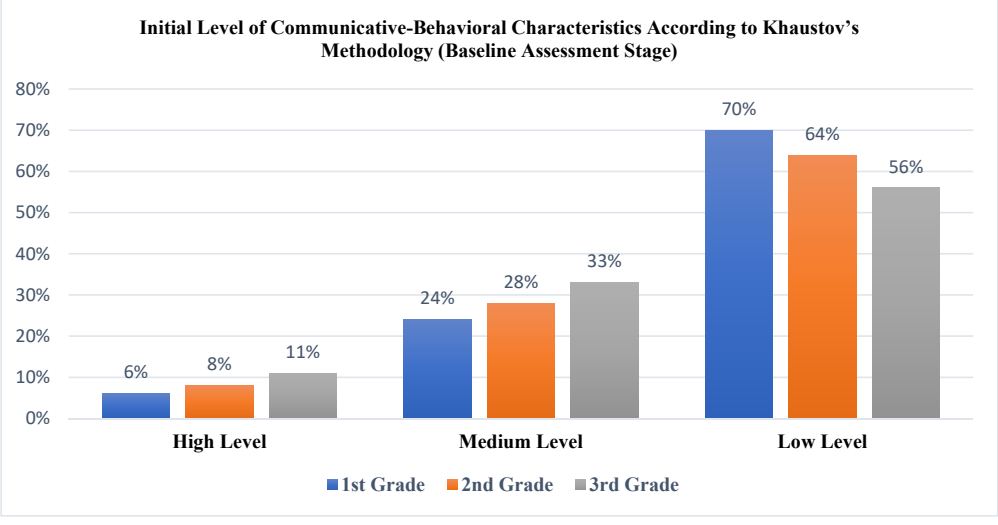
Initial level of communicative–behavioral characteristics according to Khaustov et al. (2018) protocol

Age / Grade	Number of Children	High Level	Medium Level	Low Level	M	SD
1st Grade	26	6 %	24 %	70 %	1.36	0.64
2nd Grade	28	8 %	28 %	64 %	1.44	0.61
3rd Grade	32	11 %	33 %	56 %	1.55	0.58
Total	86	8 %	28 %	64 %	1.45	0.61

To compare the distribution of levels across Grades 1-3, Pearson's χ^2 test was applied: $\chi^2 = 11.53$; $p < 0.01$. This indicates statistically significant age-related differences in the communicative-behavioral profiles of the students. The mean values also demonstrate dynamics: an increase in M from 1.36 to 1.55 and a decrease in SD from 0.64 to 0.58, indicating a gradual leveling of differences among the children and a slight improvement in communicative behavior.

Figure 3

Initial level of communicative-behavioral characteristics according to Khaustov et al. (2018) protocol (descriptive experiment)



The results in Figure 3 indicate a predominance of the low level (64%). This level is characterized by a lack of initiative in contact, weak responsiveness to prompts, reliance on gestures instead of speech, difficulties in maintaining joint activities, frequent shifts in attention, and emotional instability. These features are especially pronounced in children with primary-type ASD. As observed, the medium level increases with age (24 → 33%), reflecting partial stabilization in abilities such as maintaining contact, regulating behavior, and responding emotionally. The high level is rare (6-11%), with children at this level able to initiate contact, use spoken language appropriately, demonstrate social flexibility, and maintain engagement in joint tasks. Thus, the communicative–behavioral profile of children with emotional volitional disorders at the descriptive stage is characterized by pronounced deficits in initiative, behavioral regulation, emotional responsiveness, and maintenance of joint activities. Statistically significant differences between age groups confirm the presence of natural developmental dynamics; however, the insufficiency of this progression highlights the need for targeted formative intervention.

Discussion. The data obtained in this study allow social adaptation to be considered as a multilayered dynamic system, in which emotional, behavioral, and communicative components function interdependently (Koller & Stoddart, 2021). Within this "integrative circuit", children with emotional-volitional characteristics demonstrate a reduced level of engagement in the social environment, lagging typically developing peers in measures of social integration. These observed patterns align with the findings of those who conceptualize dialogic interaction as a meaning-making mechanism that initiates the development of cognitive processes, reflection, and communicative initiative. In this context, dialogue serves as a developmental environment in which the learner's verbal autonomy is formed (Peters & Besley, 2019). This "mosaic" pattern is manifested in a mismatch between children's intellectual abilities and their actualization in social interactions. Age-related dynamics indicate partial smoothing of certain behavioral manifestations; however, deficits in emotional regulation and voluntary control remain persistent, limiting the potential for fully functional dialogic interaction. In this context, emotional–volitional dysregulation emerges as a key factor shaping the specifics of communicative development in primary school children. Contemporary international classification systems, such as the World Health Organization's ICD-11 and the American Psychiatric Association's DSM-5, conceptualize

these disturbances within a neurodevelopmental spectrum framework, emphasizing their variability and the corresponding need for support. From a pedagogical perspective, this underscores the necessity of systematically organized interventions aimed at developing mechanisms of emotional responsiveness and communicative initiative.

Conclusion. The results of the descriptive experiment allowed for the reconstruction of the initial profile of dialogic communication in primary school children with emotional–volitional dysregulation as a complex, heterogeneous system, in which communicative activity, regulatory mechanisms, and speech manifestations form an interconnected yet disharmonious interaction circuit. It was established that, in this case, dialogic speech does not function as a stable communicative competence but as a situationally supported process, dependent on the level of self-regulation and emotional engagement. The use of a comprehensive set of methods and the Protocol for Pedagogical Assessment of Children with ASD provided an objective, multifaceted, and scientifically grounded characterization of the communicative profile of this category of students.

The data analysis revealed that the dominant level of dialogic communication development is low. It was found that initiative in verbal activity is minimal, with a significant portion of interactions limited to reactive, one-word, or stereotyped responses. Concurrently, there was insufficient variability in the thematic content of dialogue and a low ability to maintain the proposed topic. These characteristics indicate that emotional-volitional dysregulation acts as a system-forming factor, shaping the nature and quality of dialogic interaction by constraining initiative, flexibility, and the substantive elaboration of communication. At the same time, the participation of children with diverse developmental profiles, including those with ASD, demonstrates variable trajectories of communicative development, united by common difficulties in regulation and social coordination. Thus, dialogic communication under conditions of emotional–volitional dysregulation appears as a vulnerable yet potentially developable system, requiring targeted pedagogical intervention focused on the integration of regulatory, emotional, and communicative components of development.

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Integration of Digital Educational Resources and Scientific Research Activities in Higher Natural Science Education

Abstract

Introduction. The article presents the experience of integrating digital educational resources and research activities into the teaching of the elective course Ecophysiology. The study aimed to assess the effectiveness of digital learning materials and research-oriented practical tasks in developing students' research competencies. *Materials and Methods.* The experiment involved second-year students of the chemistry-biology program at the Kazakh National Women's Teacher Training University. During the study, students in the experimental groups used digital tools, including the Miro platform, to complete interactive assignments, analyze laboratory data, and present research results, whereas the control group worked through traditional methods. *Results:* The results demonstrated that the integration of digital and research components increased students' learning motivation, strengthened their research and analytical skills, and improved the quality of practical task performance. The use of digital platforms promoted collaboration, visualization of results, and critical discussion. The findings confirm that the integration of digital educational resources into ecophysiology teaching is an effective approach for enhancing scientific thinking and student engagement in higher education. *Scientific novelty.* A special learning tool has been written and tested to integrate knowledge, science, and digital resources in the digital age. The effectiveness of research-based tasks as a means of integrating tasks into the learning tool has been demonstrated. *Practical significance.* Interactive tasks prepared in the Ecophysiology textbook can be used in environmental education to achieve the expected results within the framework of this course in the learning process and to integrate students' motivation and psychological state in the communication environment and research-oriented educational activities with a digital system.

Keywords: education, digital resource, ecophysiology, academic research, AKKU-36, stress factors.

Introduction. In the era of educational digitalization, interest in the application of digital educational resources in the teaching of natural science disciplines is growing. This practical component is particularly important for courses such as Ecophysiology, where conducting experiments, making observations, analyzing data, and developing scientific thinking are essential. This course was reviewed in advance by both students and employers before being included in the educational program. A manual was developed for the course, featuring tasks on platforms focused on integrating digital educational resources and enhancing research activities (Baitasheva & Zhamanbayeva, 2023).

The Ecophysiology course requires an integrated, hands-on approach. It is impossible to master it without connecting laboratory work and assignments to the environment, observing, under laboratory conditions, the mechanisms by which organisms are affected, analyzing them, and understanding their significance. One effective approach we propose is the use of interactive tasks aimed at integrating research and digital resources. In this regard, we developed a teaching and methodological guide for the ecophysiology course that includes theoretical material, practical assignments, and links to digital educational resources. The use of these materials enabled students to complete tasks interactively, develop independent

learning skills, analyze information, and apply their theoretical knowledge in practice.

The goal of the research is to assess the effectiveness of integrated digital training materials developed for the "Ecophysiology" elective, focusing on the development of students' research skills. Utilizing digital platforms for scientific research enhances learning engagement, boosts student motivation, and fosters critical thinking and research abilities (Baitasheva & Zhamanbayeva, 2023). The study aimed to evaluate the effectiveness of the developed teaching aid for teaching the ecophysiology course and to analyze the impact of practical assignments posted on digital platforms on students' learning. At present, issues related to the digitalization of education and the integration of science and education are widely studied in pedagogical research.

The authors' bibliometric analysis of research on integrating information and communication technologies (ICT) into environmental education showed growing interest in digital pedagogy, mobile learning, virtual laboratories, and environmental simulation (Darwis et al., 2025). Husamah et al. (2025b) show that digital educational technologies, including artificial intelligence, visualization systems, and interactive platforms, enable students to develop system-based ecological thinking and research competencies. Attention is given to an interdisciplinary approach and ecological literacy. Studies show that the role of interactive technologies in teaching environmental protection subjects is increasing. Interactive platforms help students develop systems-based ecological thinking and research competencies, with particular emphasis on an interdisciplinary approach and ecological literacy (Husamah et al., 2025a, 2025b).

The integration of assignments and digital platforms has shown positive results in fostering students' critical thinking, teamwork, and independent research skills, especially in the teaching of environmental and biological subjects (Abildinova et al., 2024). Samitra & Winarni (2025) developed a mobile learning platform to prepare future teachers. The results showed that mobile learning enhances students' environmental thinking, scientific literacy, and research skills. The use of digital resources also increased motivation to study subjects related to environmental protection (Samitra & Winarni, 2025). Some studies place special emphasis on fostering inquiry-based learning in digital educational environments (Sáez-López et al., 2023). AI technologies in environmental and biological disciplines enable the modeling of physiological processes, the analysis of environmental data, and the personalization of learning (Zawacki-Richter et al., 2019).

Research suggests that integrating digital tools into subject teaching can improve students' understanding of abstract concepts and increase engagement, particularly through virtual labs and immersive environments (Mello et al., 2019). Educational resources are presented as digital tools. The basic principles, concepts, methodologies, and the effective and safe use of these resources are considered in the context of electronic educational resources (EER). These are categorized in the following order: information and educational resources, digital educational resources, educational multimedia, cyber-EER, educational cyber systems, multimedia hypertext textbooks (Hu et al., 2022). This paper examines the influence of digital resources on the scientific literacy of students in Natural Science fields and discusses related opportunities in Ecophysiology. Scientists have comprehensively reviewed types of digital educational resources, usage methods, and the obstacles and specific features affecting their adoption in teachers' professional work. They conducted a thorough evaluation of electronic textbooks in educational settings and emphasized their relevance (Makarova & Yaitsky, 2024). Ecophysiology requires not only the acquisition of theoretical knowledge but also the completion of practical tasks and the analysis of environmental factors and physiological processes. The use of digital platforms and interactive assignments enables students to master the material effectively and develop their research skills (Bogatyrova & Uglova, 2024). Bulatova & Uglova (2024) note that practical tasks posted on electronic platforms contribute to improving the quality

of learning and to fostering sustained interest in the subject (Bulatova et al., 2025).

Particular emphasis is placed on ensuring the accessibility of educational content through the integration of digital education. These resources are research tasks in the educational tool "Ecophysiology". The results were analyzed across various platforms, with the primary tool using the Miro board. Implementing new management strategies and digital technologies is essential for using scientific innovation. Studies in Kazakhstan show that electronic, teaching-based scientific initiatives reduce anxiety and improve stress resilience. At Abai Kazakh National Pedagogical University, undergraduates, PhD students, and faculty members collaborated, and this collaboration was evaluated through a SWOT analysis based on a questionnaire. The assessment revealed issues such as software limitations, a disorganized project team, and application downtime.

Despite these challenges, this model can be used to redesign or create curricula in academic settings worldwide through engagement-centered approaches. The study highlights the value of integrating electronic platforms for collaborative scientific activities between students and educators (Khlebnikova & Dolinina, 2020; Tapalova & Zhiyenbayeva, 2024). This is a useful example of how digital tools can engage learners in research activities. An analysis of 8760 online scientific publications on technology-enhanced learning in science education identified seven clusters based on bibliometric and textual data, with 36 keywords and 135 authors. The study offers valuable insights into the current state of the literature on digital learning and provides recommendations for teachers (Abiltayeva et al., 2025). To be effective in the digital age, educators must be able to use technology well. In particular, biology teachers should master various technologies to build and accurately represent their digital competency profiles (Momani et al., 2023).

This study uses offline execution of pre-prepared exercises and a quantitative descriptive research design. Developing digital literacy at the university level is essential in the context of the Fourth Industrial Revolution. The research employs an ex-post facto design. The rapid advancement of digital innovation requires education systems to develop new competencies, specifically skills in data management, proficiency with digital platforms, and the use of artificial intelligence and automated systems. Accordingly, the ex-post facto design enables analysis of the content and outcomes of digitalization in higher education, assesses the level of digital competency development among future specialists, and identifies the best approaches to improving education in the era of Industry 4.0. This method improves metacognitive ability, self-learning, and digital literacy by integrating digital platforms into the study of phenomena developing during learning (Adhani & Nursia, 2024).

Modern education in the 21st century requires students to master a range of competencies. It aims to highlight the relationship between self-regulated learning and the achievement of intended results. This approach emphasizes the use of digital resources and training that enhance motivation and foster metacognitive skills (Mustopa et al., 2020). While developing and testing a methodology for creating a set of biology learning tasks using digital educational resources, it became evident that future teachers need an approach that helps them effectively integrate these digital tools into their teaching practice (Arjaya et al., 2023). This study presents a methodology for developing biology learning activities using digital instructional materials and comparing student groups through experimental methods. It offers an alternative perspective on our previous work and may provide useful ideas for creating a comparable ecophysiological methodology at the biological science level.

Materials and Methods. The experiment involved 63 second-year students from the Kazakh National Women's Teacher Training University who selected the optional course Ecophysiology within the chemistry-biology program. The study was conducted offline and organized as a formative experiment. Students were divided into three groups and completed practical tasks using digital tools.

During the laboratory class, the students were divided into three groups (one control group and two experimental groups), and Amaranthus was cultivated while the level of microbial contamination was analyzed.

Participants. Using the methods presented on a prepared Miro board, 42 students in the experimental groups analyzed the laboratory results during the practical session. Meanwhile, 21 students in the control group analyzed Amaranthus using traditional methods without integrating digital resources.

Data collection. To facilitate the integration of digital educational resources and research activities into the teaching of the subject Ecophysiology, the following instructional materials were developed:

- a theoretical textbook was prepared in two languages, Kazakh and English;

- a dedicated educational resource was designed to incorporate practical tasks integrated with a technology-based system. The Ecophysiology Practical Methodological Toolkit includes digital versions of practical assignments and interactive exercises hosted on the Miro platform and accessible through a provided link. The activities encompass model schemes, mind maps, diagrams, collaborative projects, research reports, and visual representations of experimental results.

The implementation of research-integrated learning activities involved several stages:

- formulation of hypotheses related to ecophysiological issues, such as changes in transpiration under varying humidity conditions and the effects of light intensity on photosynthetic processes;

- observation and experimentation conducted in laboratory settings or within available learning environments. For example, during the laboratory session entitled General Patterns of the Impact of Ecological Factors on the Plant Organism, experiments and observations were conducted to examine the antimicrobial activity of members of the Amaranthaceae family under stress conditions;

- documentation of results in digital formats, including photographs, tables, graphs, and digital visualizations of stress responses in cucumber and tomato plants within the Miro environment based on the concept proposed by G. Selye;

- data analysis through collaborative discussion of the obtained findings using instructional tools such as the Fishbone diagram, T chart, Venn diagram, and SWOT analysis;

- presentation and synthesis of results through one of the aforementioned formats within a protected collaborative space on the Miro platform, followed by presentation to the instructor and fellow students.

Procedure. Analysis of research reports created by students according to criteria: the quality of the hypothesis, the validity of the method, comparison of result accuracy with references, design, and critical analysis. To evaluate the effectiveness of digital resources, pre-test and post-test tests were administered to 63 students. Before the test was used, the Ethics Committee reviewed the questions for clarity and relevance. The questionnaire consisted of five closed-ended questions: 1. Are digital resources useful for visualizing research results? 2. Does viewing the results of work with microorganisms through visual images increase interest? 3. Did digital resources facilitate data analysis? 4. Is conducting experiments with plants effective for integrating education and science? 5. Is it effective to integrate laboratory classes with digital platforms? The study consisted of three stages. In the first stage, all students took a test during the first five minutes of the organizational phase before the start of the Ecophysiology class. In the main stage, the course lasted 15 weeks.

During the laboratory sessions, the 42 students in the experimental group were taught using the sketch “microorganisms + digi_tal resources, growth stimulants + digital resour_ces, laboratory work + digital resources”. In other words, during these laboratory sessions, students carried out research tasks involving the inoculation of microorganisms, plant cultivation, the effects of stimulants and stress, and the positive and negative effects of microorganisms. The same laboratory classes were conducted traditionally for the 21 students in the control group. However, during these

sessions, the experimental group completed specially prepared digital assignments, visualized the results of their laboratory work using digital resources, and integrated them. In the experiment, digital resources were used in accordance with the links and guidelines provided in the practicum developed for the Ecophysiology course. The Ecophysiology course and the related research were conducted in a Kazakh-language group, and because the textbook was written in clear and simple language, students did not encounter any significant difficulties. Only during the first few classes did they experience some challenges in completing tasks on digital platforms. By the third stage, or the final week, students had learned to conduct systematic experiments while working on integrated tasks, present their assignments using engaging images and diagrams, support them with data from the literature, and create visualizations. At the end of the course, a final test was administered.

Results. According to current requirements, integrating digital resources into scientific research boosts students' motivation to learn. Meanwhile, teachers are actively adopting educational technologies that promote students' self-directed learning ability (Sumatokhin et al., 2020). It was determined that the effectiveness of using digital platforms for the trial implementation of pre-prepared educational materials will increase. To enhance student motivation, our research involved growing tomato and cucumber plants from seeds under laboratory conditions using the Akku-36 growth accelerator (Dzhiembayev et.al., 2023). The students in the experimental group presented the plant growth results by visualizing their responses to stress factors on a Miro board, following G. Selye's concept of stress. This activity was conducted during the laboratory session on "Adaptation and Environment: Homeostatic Responses of the Organism" to improve students' research skills.

Consider another example of students working in a group in the experimental setting. To complete digitally integrated assignments, students tested the antimicrobial activity of extracts from the plants Amaranthus hypochondriacus, A. caudatus, and A. retroflexus (family Amaranthaceae) against five microorganisms during the laboratory class on the topic "General Patterns of the Influence of Environmental Factors on the Plant Organism". The antimicrobial activity of the plant extracts was assessed using laboratory test microorganisms, including the Gram-positive Staphylococcus aureus 6538 strain and the Gram-negative strains Escherichia coli NTCC 8439, Salmonella abony NTCC 6017, and Klebsiella pneumoniae 700603, as well as Candida albicans R50. Samples of A. hypochondriacus, A. caudatus, and A. retroflexus were placed in Petri dishes and incubated at 37°C for 24 hours. The results of the Amaranthus plant antimicrobial activity are presented in Table 1.

Table 1

Antimicrobial activity of different amaranthus species against reference microorganisms

Amaranthus species	*S. aureus* 6538	*E. coli* NCTC 8439	*C. albicans* R50	*S. abony* NCTC 6017	*K. pneumoniae* 700603
A. hypochondriacus	11 ± 0.3	12 ± 1.0	10 ± 0.3	0	11 ± 0.4
A. caudatus	10 ± 0.7	10 ± 0.4	10 ± 0.4	0	10 ± 0.4
A. retroflexus	12 ± 0.7	10 ± 0.6	0	0	10 ± 0.6

The study results showed that the antimicrobial activity of Amaranth species depends directly on their phytochemical composition, the levels of biological metabolites, and the precise mechanisms underlying their selective effects on microorganisms. Among the plants examined, *A.* hypochondriacus demonstrated the strongest overall antimicrobial activity, producing inhibition zones of 12 ± 1.0 mm against *E. coli* NTCC 8439 and 11 ± 0.3 mm against S. aureus 6538. K. pneumoniae 700603 showed an inhibition zone of 11 ± 0.4 mm, while activity against Candida albicans R50 measured 10 ± 0.3 mm. No inhibitory effect was observed against

Salmonella abony NTCC 6017. These results indicate that A. hypochondriacus contains high levels of phenolic and flavonoid compounds that are effective against both Gram-positive and Gram-negative bacteria, as well as fungi. The plant's broad-spectrum antimicrobial effects indicate a substantial presence of bioactive substances, such as flavonoids, phenolic acids, and other secondary metabolites. Additionally, the bioactive and phenolic composition of A. tricolor and A. hypochondriacus leaves was evaluated across four varieties of each species. Considerable variation was observed in leaf color characteristics and betacyanin content: A. tricolor was particularly rich in betaxanthins, while A. hypochondriacus had nearly twice the betacyanin content.

A. caudatus demonstrated moderate and stable antimicrobial activity against all sensitive microorganisms tested. The areas of inhibition for S. aureus 6538, E. coli NTCC 8439, C. albicans R50, and K. pneumoniae 700603 were similar, about 10 mm, implying either a uniform or low concentration of active substances in the plant. The lack of effect on S. Abony NTCC 6017 was likely due to the natural resistance of Gram-negative bacteria. Overall, the plant exhibited uniform but relatively weak activity, indicating that while its antimicrobial spectrum remains unchanged, its potency is limited.

The literature reports that researchers evaluated the toxicity and antimicrobial effects of aqueous and ethanolic extracts of A. caudatus cultivated in different soils. These studies found that the extracts significantly inhibited Candida albicans growth, and that the extracts derived from the pre-flowering stage were non-toxic and showed promising pharmacological activity (Jimoh et.al., 2020).

A. retroflexus showed a narrow spectrum of antimicrobial activity. The greatest inhibition zone was observed against the S. aureus 6538 strain (12 ± 0.7 mm), demonstrating efficacy against Gram-positive bacteria. Overall, A. retroflexus exhibited selective antimicrobial activity, primarily against Gram-positive bacteria. This feature emphasizes its narrow and targeted antimicrobial spectrum. More generally, Amaranthus species display significant differences in their antimicrobial potential, with some exhibiting selective and others broad-spectrum activity.

Moderate activity (10 ± 0.6 mm) was observed against K. pneumoniae 700603, a Gram-negative strain. No activity was detected against C. albicans R50 and S. NTCC 6017, indicating a lack of antifungal and anti-Salmonella effects. This variability supports their potential applications in pharmacological studies, the development of natural antimicrobial agents, and use as biologically active additives. The statistical data for amaranth plant activity are summarized in Table 2.

Table 2

Amaranth plant activity indicator

Type	Activity level	Effect spectrum	Feature
A. hypochondriacus	High	Broad spectrum (Gram+ / Gram - / mushroom)	The most active species
A. caudatus	Average	Stable but limited	Activity is uniform but low
A. retroflexus	Selective	Restricted spectrum (mainly Gram+)	C. does not affect Albicans and Salmonella

According to the results, A. hypochondriacus has the broadest antimicrobial activity of all the species examined, making it a promising candidate for natural antimicrobial agents. In contrast, A. retroflexus demonstrated strong activity only against Gram-positive bacteria, limiting its potential because of its poor antifungal effectiveness and weak activity against Salmonella strains. Students evaluated this study using the Fishbone method on Miro. com. Each Amaranthus species displays a unique antimicrobial profile, allowing for targeted use in pharmacology, microbiology, and biotechnology.

This analysis was carried out in the experimental group, which consisted of 42 students whose classes followed the scheme: "Microorganisms + digital resources, growth stimulants + digital resources, laboratory work + digital resources". In the control group, 21 students were taught through traditional laboratory classes. In the pedagogical experiment conducted according to this scheme, digital resources were implemented based on the links and instructions provided in the practicum for the Ecophysiology course. During the research, students uploaded and analyzed visual materials on the platform, including photographs of their laboratory work related to pre-designed schemes and methods, as well as the final products developed based on materials reviewed from the literature. When the development of skills during the experiment was analyzed through preliminary interviews, the students' progress in developing these skills under laboratory conditions was assessed by comparing various types of research competencies before and after the integration of digital technologies (Table 3).

Table 3

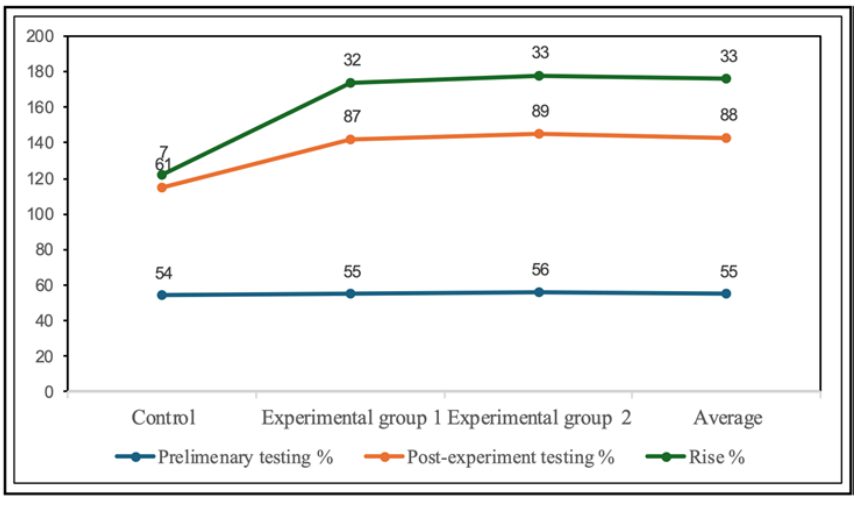
Analysis to develop research

№	Skills character	Before the integration	After integration
1	hypothesis formulation	low / medium	medium/high
2	practice planning	teacher facilitator	individual work of students
3	experience control	teaching consultant	independent work of students
4	data analysis visualization	creating graphs and tables	special, smaller triad, visualization by fishbone
5	conclusion	presentation	critical analysis, references to literature, and discussion with the views of scientists

The criteria and questions used to assess these skills were discussed and approved by the scientific community and ethics committee. At the first stage, preliminary assessment tests were administered to evaluate the students' knowledge. After the main stage, which was conducted in accordance with the scheme presented above, a final test was administered. Before the experiment began, all groups had a similar level of preparedness, with an average score of 55%. After integrating digital resources, a significant change was observed in the experimental groups, with the medium and high levels increasing from 55% to 88% (Figure 1).

Figure 1

Comparative analysis of the experimental results



Students reported that designing digital tasks after laboratory work facilitated collaboration, created a psychologically supportive environment, and made learning more engaging. Sig-

nificant challenges arose when using the pre-prepared training manual for the Ecophysiology course, and students found it challenging to use the Miro platform without clear instructions from the tutorial. While some laboratory practices are hard to adapt to digital formats because of the importance of direct scientific observation, tasks completed with Miro were organized and visually effective.

Discussion. When comparing our results with findings reported in the literature, we see that our experience is consistent with many current research trends. Researchers have examined how integrating vertical laboratories and immersive technologies shapes the learning process in six key directions. They argue for understanding learning as an ongoing process, one that involves thinking, conscious reflection, acceptance, and teamwork, rather than a fixed outcome. Guided by these insights, we designed our research using the Miro board to gain new experiences and reconsider existing ideas. Based on these principles, scientists have identified four complementary modes of learning, and this study shows how these cycles function within a hybrid environment (Baitasheva et al., 2025). We enhance our research capacity by engaging in a repetitive, interactive process that does not have a distinct starting or ending point (Kee & Zhang, 2022). The modernization of the learning process and the educational environment supports educators in seeking answers to their own questions and applying creative approaches, which ultimately leads to professional growth (Muhidova, 2020).

The training and education of future biology teachers, challenges of digitalization, and the need to foster digital competence in pedagogy were addressed, while experiences from scholars regarding the use of educational platforms were considered (Yesmakhanova et al., 2024). While e-learning resources offer students flexible and practical programs, the analysis indicates that combining these with face-to-face sessions is even more effective (Galvis & Carvajal, 2022). The problems we encountered are also observed in other studies. Consequently, there is a need to provide guidance on digital equipment, ensure accessibility, and standardize methods according to modern requirements. Since future biology teachers participate in this course, they use online materials to analyze their results. This study's approach helps students complete assignments while fostering research, discussion, and digital skill development. Integrating digital tools into ecophysiology supports research indicating that teacher training should develop both technical and technological integration skills.

Based on the experimental results, the digital materials developed for the Ecophysiology course improved the learning process by enabling students to analyze laboratory work on the platform, particularly the level of microorganism dependence and the stress response of plants to stimulants. As shown in Figure 1, the improvement in the control group was 7%, while the improvement in the experimental group showed a significant 33% increase, demonstrating the effectiveness of using digital resources. It contributed to improved academic performance. Compared with the control group, the analysis showed that digital visualization tools were effective for students in the experimental group, enabling convenient and rapid analysis of multiple data sets. Analysis of the data presented in Tables 1 and 2 on the study of microorganisms, along with the results of laboratory work on growing plants using growth stimulators, was more effective because digital technologies allowed students to analyze the results collaboratively in an engaging psychological environment. The study found that students were able to visualize data effectively using digital resources. The results obtained demonstrated strong performance indicators compared with those reported in the studies of other scholars mentioned above.

Conclusion. This study indicated that integrating digital educational resources and student research activities into the Ecophysiology course effectively increases student engagement and participation in the learning process. The use of digital educational resources in teaching Ecophysiology also helps students develop research skills, including formulating hypotheses, designing experiments/observations, collecting and analyzing data, critically interpreting results, and presenting conclusions. Miro was a useful digital platform for visualizing ideas, enabling team collaboration, supporting research, designing

products, and gathering feedback. To integrate successfully, students should be taught how to use digital platforms, providing technical support, balancing digital and lab work, designing research-based tasks, and evaluating course preparation aids.

Based on the Ecophysiology course, a 15-week experiment was conducted under laboratory conditions to cultivate amaranth plants. The results showed that monitoring their resistance to microorganisms and analyzing the use of growth stimulants through pre-prepared digital platforms improved lesson quality. The use of digital materials in the practical manual designed for the Ecophysiology course had a positive effect on students' communication during data analysis and on their psychological well-being. Their interest in analyzing lesson results increased, and the students' average performance rose from 55% to 88%, demonstrating the effectiveness of using digital tools for analysis.

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The Role of Digital Didactics in the Development of the Linguistic Personality in Primary School

Abstract

Introduction. The article considers the role of digital didactics in the formation of the language personality of primary school students. In the context of the digital transformation of education, scientific analysis of the possibilities of digital storytelling, gamification, interactive platforms, and multimodal learning resources for the development of students' vocabulary, communicative activity, and basic language skills is relevant. *Methodology and methods.* The study was conducted in the format of a theoretical and analytical literature review. The Scopus, Web of Science, and Google Scholar databases were used to select scientific publications. The study used comparative analysis, descriptive analysis, and content systematization methods. *Results*. The analysis showed that the impact of digital didactics on the language development of primary school students is manifested in several areas: increasing motivation to read, expanding vocabulary, improving pronunciation, listening, reading, and writing, personalizing learning, and providing instant feedback. *Scientific novelty.* The scientific novelty of the study is the comprehensive systematization of the impact of digital didactics on the formation of the linguistic personality of primary school students in the unity of digital storytelling, gamification, and neurodidactic principles. The article substantiates the role of digital tools in language education not only as a technical resource, but also as a pedagogical system that supports communicative and cognitive development. *Practical significance.* The results of the study are an effective methodological guide for primary school teachers, methodologists, and developers of digital educational resources.

Keywords: digital didactics, linguistic personality, primary school, digital technologies, online learning, artificial intelligence.

Introduction. The modern educational space is undergoing a radical transformation under the influence of digital technologies. This process also affects the content of language education in primary schools, requiring new approaches to developing students' vocabulary, improving their oral and written communication skills, and increasing their communicative activity. Since the primary school period is a crucial stage in the formation of a linguistic personality, the content and methodological foundation of the teaching tools used at this age are of particular importance (Kuhl, 2011; Thomas et al., 2019).

Digital didactics enables the multimodal presentation of educational material, immediate feedback, and the organization of collaborative and personalized learning. In particular, digital storytelling, interactive tasks, gamified exercises, and mobile learning tools are considered promising approaches to developing language skills (Wu & Chen, 2020; Yu & Wang, 2025). However, digital technology alone does not automatically lead to high learning outcomes;

its effectiveness depends on pedagogical goals, age-specific characteristics, and the appropriate management of cognitive load (Howard-Jones, 2014; Sailer & Homner, 2020).

Although digital storytelling, gamification, and neurodidactic principles have been extensively examined as separate areas in current research, their interrelationships in the formation of the linguistic personality of primary school students have not yet been sufficiently systematized. Therefore, a comprehensive examination of the impact of digital didactics on language development is highly relevant. The purpose of this article is to analyze the role of digital didactics in the formation of the linguistic personality of primary school students and to systematize the potential of digital storytelling, gamification, and neurodidactic principles in this process.

Digital didactics is considered a methodological approach that modernizes the learning process through information and communication technologies. Its main characteristics include interactivity, visualization, accessibility, the personalization of student activity, and the presentation of learning content in various formats. The digital environment shapes the student as a content creator rather than merely a receiver of information, thereby creating favorable conditions for the development of a linguistic personality (Wu & Chen, 2020; Yu & Wang, 2025).

Effective language development in early childhood depends on emotional engagement, repeated experience, meaningful context, and multichannel perception. Neurocognitive studies show that early language learning is closely related to complex sensory and social experiences (Kuhl, 2011; Shams & Seitz, 2008). Therefore, the coordinated use of video, audio, text, and action-based elements in digital didactics can support students' language activity. Digital storytelling is an approach based on the creation of a meaningful story through the combination of text, images, audio, animation, and video elements. This method enables the comprehensive development of students' speaking, writing, listening comprehension, and interpretive skills. Digital storytelling has been shown to enhance students' learning motivation, creativity, and critical thinking (Yang & Wu, 2012; Sarıca & Usluel, 2016).

In the context of language learning, digital storytelling encourages students to structure their own thoughts, establish plot connections, and use vocabulary appropriately, rather than simply repeating a prepared text. Studies conducted in school English classes show that digital storytelling has a positive impact on language motivation and learning outcomes (Kuo-Ping et al., 2018). In the CLIL context in primary school, digital storytelling has improved students' English-speaking skills and the quality of collaborative work (Fan & Chen, 2023). In addition, digital storytelling strengthens students' linguistic confidence and increases their willingness to communicate in a foreign language. Multimodal storytelling experiences support emotional engagement, persistence, and oral participation (Shen et al., 2024). In this regard, digital storytelling is considered a productive pedagogical tool for shaping the linguistic personality of primary school students.

Gamification is based on the introduction of game elements-points, levels, rewards, competition, and immediate feedback-into the educational process. Studies show that gamification can increase student motivation, engagement, and learning outcomes (Bai et al., 2020; Sailer & Homner, 2020). In language teaching, gamification is particularly effective for vocabulary acquisition, the consolidation of grammatical patterns, and the activation of short communicative tasks (Dehghanzadeh et al., 2021; Zou et al., 2021).

In primary school, the use of mobile gamified applications has been shown to improve students' achievement and self-efficacy (Rachels & Rockinson-Szapkiw, 2018). Digital game-based language learning can also increase students' willingness to speak and reduce language anxiety (Reinders & Wattana, 2015). However, when used inappropriately, game elements can distract students from the learning content. For this reason, gamification should directly serve the learning objective, and competitive elements should be adapted to students' age and

psychological characteristics (Vandercruysse et al., 2013; Shortt et al., 2023). Neurodidactics considers the learning process in relation to brain function, attention, memory, emotion, and motivation. While modern science recognizes the potential value of neurobiological data in education, it also emphasizes the need to avoid neuromyths (Howard-Jones, 2014; Thomas et al., 2019).

In language education, it is important, from a neurodidactic perspective, to diversify students' sensory experiences, create an emotionally positive environment, and gradually increase the complexity of information. Multisensory learning can simultaneously activate visual, auditory, and tactile channels and support information retention (Shams & Seitz, 2008). Research on early language experience also shows that children's language development occurs most effectively in an environment that is meaningful, repetitive, and grounded in social interaction (Kuhl, 2011). In this sense, digital storytelling and gamification, when combined with neurodidactic principles, form a comprehensive methodological framework that contributes to the development of the linguistic personality of primary school students.

Materials and Methods. This study was conducted as a theoretical and analytical literature review aimed at examining the potential of digital didactics in the formation of the linguistic personality of primary school students. Domestic and international scholarly publications were analyzed using comparative analysis, descriptive analysis, and content systematization. The literature was selected from the Scopus and Web of Science databases, with Google Scholar used as an additional search tool. The main search focused on works published between 2015 and 2025. At the same time, several foundational studies published between 2008 and 2014 on digital learning, multisensory perception, and language development were additionally included to clarify the theoretical basis of the study. The search strategy employed the following keywords and their combinations: digital didactics, digital storytelling, gamification, digital game-based language learning, primary school, elementary education, language development, language skills, neurodidactics, and multisensory learning. During the search process, the Boolean operators AND and OR were used depending on thematic relevance.

The sources were selected according to the following criteria: the article had to be published in a peer-reviewed scientific journal; the journal had to be indexed in the Scopus or Web of Science databases; priority was given to studies published in Q1–Q2 journals; the study had to address the use of digital technologies in education, particularly in the development of language skills; and the educational context had to involve primary school students, children of early school age, or a methodologically comparable age group. As a result of the selection process, 20 scientific publications were included in the final analytical corpus of the study. These publications comprised empirical studies, meta-analyses, systematic literature reviews, and articles of high theoretical significance.

The impact of digital didactics on the language development of primary school students was systematized across the following areas of analysis: types of digital didactic technologies, including online platforms, mobile applications, digital storytelling tools, gamification elements, VR/AR technologies, and AI-based learning resources; digital learning methods, such as game-based learning, adaptive learning, personalized learning, and multimodal tasks; effects on language skills, including vocabulary, listening, reading, writing, pronunciation, and communicative activity; and effectiveness indicators, such as learning motivation, level of participation, improvement in language outcomes, cognitive activity, and student autonomy. Thus, the methodology employed in this study makes it possible to systematically analyze scholarly works related to digital didactics, assess their impact on language education in primary schools, and identify the main research directions within the field.

Results. The conducted literature analysis showed that the influence of digital didactics on the development of the linguistic personality of primary school students is manifested in several interrelated areas. As a result of systematizing

the reviewed scientific works, four main findings were identified.

First, digital didactics increases the interactivity of the learning process and enhances students' linguistic activity. Online platforms, multimedia tasks, digital storytelling tools, and game-based exercises shape students not merely as receivers of ready-made information, but as content creators and active participants in linguistic activity. Digital storytelling, in particular, is effective in developing students' abilities to compose texts, organize ideas, narrate stories, and communicate orally (Yang & Wu, 2012; Sarıca & Usluel, 2016; Kuo-Ping et al., 2018).

Second, digital technologies enable the comprehensive development of language skills. Studies have shown that they have a positive effect on expanding vocabulary and improving listening, reading, writing, and speaking skills. The multimodal nature of digital resources, which combine text, sound, video, and action-based elements, facilitates the perception and processing of information. This corresponds to the age-specific characteristics of primary school students and improves the memorization of language material (Shams & Seitz, 2008; Kuhl, 2011; Wu & Chen, 2020).

Third, gamification and digital game-based learning appear to be powerful factors in enhancing learning motivation. Elements such as points, levels, rewards, competition, and immediate feedback increase students' interest in lessons and motivate them to complete language tasks. Such approaches are especially effective in consolidating vocabulary, reviewing grammatical structures, and organizing short communicative exercises (Rachels & Rockinson-Szapkiw, 2018; Bai et al., 2020; Sailer & Homner, 2020; Zou et al., 2021).

Fourth, the effectiveness of digital didactics depends not on the technology itself, but on its pedagogically targeted use. As the analysis shows, digital tools allow for the individualization of learning, the assignment of tasks according to students' learning pace, and the provision of immediate feedback. However, these opportunities can only be fully realized when teachers' methodological preparation, the quality of assignments, and the balance between the digital environment and traditional language communication are maintained (Howard-Jones, 2014; Thomas et al., 2019; Shortt et al., 2023). In general, the synthesis of the analyzed works revealed three main effects of digital didactics on language education in primary schools: the activation of language activity, increased motivation and engagement, and the personalization and multimodal presentation of learning content. These results demonstrate that digital didactics has significant potential for shaping the linguistic personality of primary school students.

Discussion. The conducted literature analysis showed that digital didactics has considerable potential for developing the linguistic personality of primary school students. However, its effectiveness is determined not merely by the use of technology itself, but also by its pedagogical purpose, content, and age appropriateness. From this perspective, digital didactics should not be regarded as a substitute for traditional teaching, but rather as a component of the educational system that complements it in terms of both content and methodology. Studies often emphasize that digital tools increase students' motivation to learn, enhance their interest in lessons, and create conditions for active participation in language-related activities. For primary school students, educational material must be presented in a visual, interactive, and emotionally engaging manner. For this reason, digital storytelling, game elements, and video and audio materials facilitate the perception of language material. In a digital environment, students do not simply receive ready-made information; they process and reconstruct it, creating their own linguistic products. This directly influences the formation of a linguistic personality, as students develop the ability to express themselves, compose texts, and make communicative choices (Yang & Wu, 2012; Sarıca & Usluel, 2016; Kuo-Ping et al., 2018).

Digital storytelling technology is especially significant. It enables students to create meaningful stories by combining images, sounds, text, and video. Such work develops

language skills not in isolation, but in an integrated manner. For example, a student first understands the text, then plans it, narrates it in writing or orally, and finally presents the completed product. Each of these stages involves reading, writing, speaking, and listening skills. In addition, digital storytelling enhances students' creativity and linguistic autonomy, as they are given a certain degree of freedom in organizing content (Wu & Chen, 2020; Fan & Chen, 2023). Gamification also warrants discussion as an important direction in digital didactics. Elements such as points, rewards, levels, competition, and feedback motivate students to complete tasks and make the learning process more dynamic. Although the motivational potential of gamification is well documented in the literature, its overuse may create methodological risks. If students' attention is focused solely on scoring points or winning rather than on the learning content, the educational goal may become secondary. Therefore, the main function of gamification is not merely to attract students through external rewards, but to gradually involve them in meaningful language activities. The language task itself should remain at the core of the game (Vandercruysse et al., 2013; Bai et al., 2020; Sailer & Homner, 2020).

Another important advantage of digital didactics is its capacity to personalize learning. In primary school, students differ in their language proficiency, learning pace, and cognitive abilities. Adaptive platforms and digital learning tools can modify tasks based on learners' errors, response speed, and level of mastery. This is particularly effective for vocabulary consolidation, the acquisition of grammatical patterns, and the teaching of language material that requires frequent repetition. However, personalization should not rely solely on algorithmic adaptation; teachers' professional supervision and pedagogical judgment remain crucial. Digital systems can support learners' educational trajectories, but they should not control them entirely (Rachels & Rockinson-Szapkiw, 2018; Shortt et al., 2023).

The results of the analysis show that the influence of digital didactics on the formation of a linguistic personality cannot be limited to cognitive achievements alone. A linguistic personality is not merely a student with a rich vocabulary or strong grammatical competence, but also a person who communicates effectively, expresses ideas, and understands cultural and social meanings. In this regard, students' collaborative work, participation in dialogue, exchange of opinions, and creation of a shared product are of particular importance in the digital environment. Digital platforms can support formats such as collective storytelling, collaborative text creation, and online discussions. Such activities contribute to the development of communicative competence and connect language knowledge with social experience.

At the same time, several factors may hinder the pedagogical effectiveness of digital technologies. First, in some cases, digital learning may encourage the frequent use of ready-made answer templates, which can weaken spontaneous speech and independent thinking. Second, prolonged and irregular use of digital devices can negatively affect students' attention span, increase fatigue, and disrupt healthy learning habits. Third, if teachers' digital competence is insufficient, the didactic potential of technology may not be fully realized. Therefore, the introduction of digital didactics should not be limited to an increase in the number of tools alone but should be accompanied by stronger methodological training for teachers. This makes it possible to provide a more balanced interpretation of the advantages of digital tools discussed above.

Neurodidactic principles are an important direction that provides a scientific basis for the digital language environment. Multichannel perception, emotional support, short and structured information, and periodic repetition all correspond to the learning characteristics of primary school students. Digital platforms are well-suited to implementing these principles: sound can be added to text, movement to images, and feedback to tasks. However, when drawing on neurodidactics, it is necessary to distinguish between evidence-based principles and scientifically unfounded "neuromyths." Therefore, when developing digital tasks, linguistic goals, cognitive load, and age-specific characteristics should be considered before

design features (Howard-Jones, 2014; Thomas et al., 2019).

As a result of the comparative analysis of the literature conducted in this study, three basic conditions for the effective use of digital didactics were identified. First, a digital tool should be aimed at a specific linguistic outcome. Second, it should stimulate students' productive language activity, including speaking, writing, presenting, and expressing opinions. Third, digital and traditional forms of teaching should be used in a balanced and complementary manner. Only when these conditions are met can digital didactics become a methodologically sound mechanism for developing the linguistic personality of primary school students. In general, the reviewed scholarly works demonstrate that digital didactics is a promising direction in language education in primary schools. However, its effectiveness lies not in technological innovation itself, but in its pedagogical relevance. While digital storytelling, gamification, and adaptive learning tools can each produce positive results when used separately, they may be more effective when integrated into a unified model that comprehensively supports students' linguistic development. In this regard, future studies should focus not merely on describing individual digital didactic tools, but on empirically verifying their cumulative effect on the formation of a linguistic personality.

Conclusion. The conducted analysis showed that digital didactics has significant pedagogical potential for shaping the linguistic personality of primary school students. Digital storytelling, gamification, interactive platforms, and multimodal learning resources enhance students' language activity, expand their vocabulary, and contribute to the comprehensive development of speaking, listening, reading, and writing skills. In addition, the digital environment enables the individualization of learning materials, the provision of immediate feedback, and the strengthening of students' motivation to learn.

The results of the study revealed that the effectiveness of digital technologies depends not on their quantity, but on their pedagogically justified use. Digital tools produce strong results only when they complement traditional teaching and engage students in active language use. Particularly in the context of primary education, it is important to adapt digital methods to students' age-specific characteristics, cognitive abilities, and specific language-learning goals. At the same time, several limitations should be considered in the use of digital didactics: excessive dependence on technology, the risk of reduced face-to-face communication, and insufficient digital and methodological training among teachers. In this regard, future research should empirically assess the impact of digital tools on speech quality, linguistic autonomy, and the long-term learning outcomes of primary school students. In conclusion, digital didactics is an effective direction for improving language education in primary schools. When organized on a sound methodological basis, it becomes an important educational resource that supports students' communicative competence, creative thinking, and the formation of a linguistic personality.

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Original Article

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The Impact of Digital Media on the Aggressive Behavior of Adolescents in Single-Parent Families

Abstract

Introduction. This article examines the impact of digital media on the aggressive behavior of adolescents raised in single-parent families. The process of digitalization in modern society directly influences adolescents' social adaptation, value orientations, and the formation of behavioral models. In particular, the limited emotional support characteristic of single-parent family environments intensifies the influence of the digital environment. *Methodology and Methods.* The study aimed to identify the mechanisms through which digital media factors affect the formation of aggressive behavior among adolescents in single-parent families. The study employed theoretical analysis, comparative method, content analysis, and interpretation of empirical data. *Results.* The findings indicated that aggressive content in digital media, cyberbullying, violent elements in online games, and deviant narratives on social media significantly influence adolescents' behavioral responses. *Scientific Novelty.* The scientific novelty of the study lies in the comprehensive analysis of the influence of digital media within the socio-psychological context of single-parent families and in the systematization of media-related factors that contribute to the formation of aggression among adolescents. *Practical Significance.* The results of the study may be applied in the development and implementation of pedagogical and psychological interventions aimed at preventing aggressive behavior among adolescents and improving media literacy in the context of single-parent families.

Keywords: digital media, single-parent families, adolescent, aggressive behavior, cyberbullying, social media.

Introduction. The processes of globalization and digitalization have a significant impact on the social structure of society, the family system, and the behavioral patterns of adolescents. The widespread use of digital media, including social networks, video platforms, online games, and messaging apps, has fundamentally changed the way adolescents communicate. Currently, the virtual environment has evolved from a simple source of information to a crucial space for adolescents' personal development. Adolescence is a complex stage of development characterized by psycho-emotional instability, the search for social roles, and the process of self-identification. During this period, the influence of external factors becomes particularly pronounced. This effect may be even more significant among adolescents who grew up in single-parent families, where limited social supervision and emotional support may increase their susceptibility to the influence of the digital environment.

In the context of today's digital society, the safety of adolescents on the Internet has become an important scientific and social issue. Empirical studies have shown that the level of parental involvement and digital literacy directly affects the likelihood of adolescents

becoming victims of cyberbullying. In particular, inadequate parental supervision and low levels of digital literacy are among the key factors that increase adolescents' vulnerability to risks in the digital environment. This highlights the growing importance of scientific research on the role of family environment and parental mediation in shaping adolescents' digital behavior (Ayhan et al., 2025). In Kazakhstan, the growing level of aggression and deviant behavior among teenagers has become a matter of public concern. For example, in 2026, law enforcement agencies reported that a 10th-grade student in the city of Kulsary attacked his peers with an axe after a conflict (zhasalash.kz, 2026). Additionally, a student's attempted suicide was reported in a private school in Almaty, where bullying was identified as a major contributing factor to the tragic situation (egemen.kz, 2026). These cases highlight the psychological vulnerability of adolescents and the growing importance of studying the impact of social and digital environments on their behavior. These examples highlight the importance of scientific research on the factors contributing to the development of aggressive behavior among adolescents, including the influence of the digital environment.

In recent years, the rise of aggressive behavior, the spread of cyberbullying, and the prevalence of violent content in the online environment have garnered significant attention from the scientific community. However, the impact of digital media on adolescents from single-parent families has not been extensively studied. Analyzing the relationship between family structure and media influence is crucial for contemporary socio-educational research. In this regard, the purpose of the study is to identify and analyze the factors that influence the development of aggressive behavior in adolescents who grow up in single-parent families.

The objectives of the study are as follows:

– to study the theoretical foundations of adolescent aggression;

– to identify the socio-psychological characteristics of single-parent families;

– to analyze the mechanisms through which digital media influence adolescents' behavior;

– to determine the relationship between media-related factors and aggressive behavior. The scientific novelty of the study lies in the comprehensive study of the relationship between the influence of digital media and the behavioral reactions of adolescents in single-parent families. The results of the study can be used in the organization of pedagogical, psychological, and social measures aimed at preventing adolescent aggression.

Materials and Methods. This study was conducted using a theoretical and analytical approach. The data sources were scientific articles indexed in the international database Scopus and published between 2000 and 2025. The following keywords were used in the selection process: "digital media", "teenage aggression", "cyberbullying", "single-parent family", "family structure", "online violence", and "behavior development". The inclusion criteria included publication in peer-reviewed scientific journals, reliance on empirical data, the study of the impact of digital media on adolescent behavior, and the consideration of family structure as a research factor.

The following research methods were used:

- a general literature review (with elements of a systematic review) was conducted to analyze international empirical studies on the impact of digital media on adolescent aggression;

- a content analysis was performed to systematize the forms of aggression and media-related influencing factors identified in scientific publications.

Additionally, news articles published in Kazakhstan since the beginning of 2026 regarding adolescent aggression and deviant behavior were selected as additional research objects. In particular, information materials published in the media about school violence, suicide attempts, and aggressive behavior by students were analyzed (egemen.kz, 2026; zhasalash.kz, 2026).

The data were analyzed using a qualitative comparative and interpretive approach. The comparative approach was used to identify differences between adolescents from full and single-parent families, while the interpretive approach was used to summarize and interpret the patterns observed in the studies considered.

The study followed a three-stage theoretical and analytical approach:

- in the first stage, international scientific publications were selected, and a database of data sources was created;
- in the second stage, the results of empirical studies were systematized;
- in the third stage, the relationship between digital media and family structure factors was theoretically substantiated.

This methodological approach allowed for a comprehensive scientific analysis of the impact of digital media on the aggressive behavior of adolescents raised in single-parent families.

Results. A systematic analysis of scientific publications indexed in the Scopus database showed that the impact of digital media on aggressive behavior among adolescents is multifactorial and context-dependent. Grouping the studies based on their content revealed several key areas of focus. Firstly, it was found that frequent exposure to aggressive content in the digital space is associated with increased levels of verbal and behavioral aggression among adolescents. In particular, online games containing elements of violence, aggressive video content, and cases of cyberbullying have been identified as factors that increase the likelihood of aggression. To present these factors in a structured and comparative manner, taking into account new media, visual narratives, and social influence, table 1 is proposed.

Table 1

The impact of aggressive digital media content on adolescents' behavioral responses

Type of Digital Environment	Content Characteristics	Psychological Effects	Behavioral Responses	Long-term Consequences
Aggressive media content (videos, reels, short-form clips)	Physical and verbal aggression, conflict-based and sensational narratives	Desensitization to violence, emotional numbing	Increased impulsivity, verbal hostility, and reduced empathy in interpersonal communication.	Stabilization of aggressive behavioral patterns
Cyberbullying	Online harassment, humiliation, exclusion, and digital intimidation	Anxiety, decreased self-esteem, and emotional distress	Social withdrawal or retaliatory aggression	Depressive tendencies, chronic insecurity
Violent elements in online games	Shooting, combat simulation, and competitive violence mechanics	Normalization of aggression, reduced sensitivity to harm	Imitation of risky or confrontational behavior patterns	Increased risk orientation, potential behavioral dependency
Deviant narratives in social media	Romanticization of self-harm, radical ideologies, and glorification of antisocial success models	Value disorientation, cognitive distortion of social norms	Justification or rationalization of deviant behavior	Social maladaptation, erosion of normative boundaries

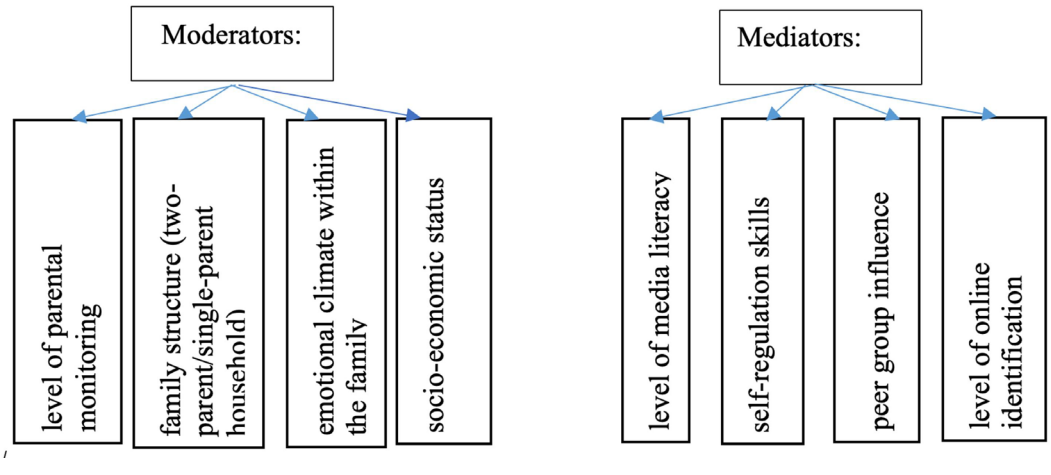
Table 1 systematizes the main forms of aggressive and deviant content in the digital media environment and shows their multifaceted impact on adolescent behavioral outcomes. The analytical structure reflects a consistent logic, from the type of digital environment and the characteristics of its content to the psychological effects, immediate behavioral outcomes, and potential long-term consequences. The findings suggest that repeated exposure to aggressive media stimuli can contribute to desensitization processes, shifts in emotional regulation, and the normalization of violence as a socially acceptable behavioral strategy. In particular, cyberbullying environments appear to generate internal psychological stress, which can manifest either in social withdrawal or in compensatory aggression. Similarly, aggressive online games can reinforce confrontational behavioral scripts through interactive modeling mechanisms.

Deviant narratives on social media, particularly those that romanticize self-harm or models of antisocial success, can disrupt adolescents' value systems and contribute to the cognitive legitimization of deviant practices. In general, the table presents the concept of online aggression as an indirect socio-psychological mechanism that influences the formation of adolescent behavior through cumulative exposure, symbolic modeling, and normative reconfiguration processes. High levels of moral detachment, peer pressure, and low levels of anger regulation have been identified as key predictors of aggressive behavior, including bullying and cyberbullying (Sánchez-Jiménez et al., 2023).

Secondly, the family structure factor is an important protective factor. International empirical studies show that adolescents raised in single-parent families may exhibit increased psycho-emotional vulnerability. Excessive use of digital technologies can lead to increased tension in parent-child relationships and disrupt family harmony. Research suggests that prolonged online exposure, the influence of digital media on behavior, and inadequate parental supervision are significant factors contributing to behavioral changes and aggressive responses in adolescents (Page Jeffrey, 2024). In addition, low parental control and insufficient emotional support create conditions that increase the influence of digital media. Therefore, the data obtained suggest that the influence of digital media is determined by both moderators and intermediaries.

Figure 1

Structural Model of Moderating and Mediating Variables in Adolescent Digital Media Exposure



In this process, family structure (full or single-parent family), parental control, emotional family climate, and socioeconomic status are considered as confounding factors, as these variables can either enhance or diminish adolescents' sensitivity to the digital environment. Intermediate variables include media literacy, self-regulation skills, peer influence, and online identity. These factors determine the psychological perception of digital content and explain the mechanism through which it translates into behavioral responses. Thirdly, the impact of digital media is indirect and manifests itself through intervening factors. Research shows that media literacy, self-regulation skills, and peer influence act as mediators in the development of aggression. Additionally, parental involvement is recognized as an important factor in preventing cyberbullying; however, information about how parents respond to cyberbullying incidents remains limited. Moreover, children often perceive cyberbullying as a normal phenomenon and believe that parents should not intervene (Young & Tully, 2019).

Cyberbullying is a specific form of bullying that occurs in the digital environment and is widespread among students. Its main feature is

that it is carried out in a covert manner using digital technologies, making it difficult to detect. However, the psychological and social consequences of cyberbullying can be just as detrimental as those of traditional face-to-face bullying (Wong-Lo & Bullock, 2011). A content analysis of the literature showed that the main forms of aggression among teenagers include cyberbullying, verbal aggression, social isolation, and online harassment, which are typically expressed through negative comments on social media, offensive messages, the disclosure of personal information, and online stalking.

In addition, the influence of the media was systematically identified. Key factors affecting the media include the duration of social media use, the level of anonymity in the digital environment, insufficient parental control, and low media literacy. The results of the content analysis show that the digital environment directly affects the behavior of adolescents and is a significant socio-psychological factor contributing to the development of aggressive behavior. For example, the incident that occurred in 2026 in Kulsary, Kazakhstan, when a student attacked his peers with a weapon, illustrates the complex nature of adolescent emotional instability and the influence of their social environment. Scientific literature also suggests that exposure to aggressive content and cyberbullying in the digital realm can contribute to the development of such behavior (Kowalski et al., 2014)

Fourth, several studies highlight the dual nature of the digital environment. Online communities can serve as a source of social support and, in some cases, reduce aggression. This finding suggests that viewing digital media solely as a risk factor is insufficient. In this context, family structure, particularly the ability to provide care and parental control in two-parent families compared to single-parent families, has a significant impact on adolescent digital behavior. To further explore how these factors operate in practice, a comparative analysis was conducted focusing on adolescents from different family structures. A comparative analysis revealed notable differences in the digital behavior of adolescents from two-parent and single-parent families. In particular, adolescents from single-parent families tended to spend more time on social media and were more likely to engage in aggressive behavior in the digital environment. This pattern may be related to relatively low levels of parental control and insufficient emotional support.

In contrast, adolescents from intact families, despite greater engagement in digital media, demonstrated better self-regulation skills and benefited from parental control, which contributed to a reduction in aggressive responses. Overall, the comparative analysis suggests that family structure is a key social factor influencing adolescent behavior and aggression in the digital environment. Based on these empirical findings, it becomes necessary to consider practical approaches aimed at reducing online aggression and strengthening adolescent resilience. Based on these findings, three primary strategies for protecting adolescents and enhancing cybersecurity can be identified: promoting media literacy, enhancing parental digital competence, and strengthening psychological support systems. These strategies are widely recognized in cyberbullying prevention research and contribute to effective cyber protection and psychological resilience among adolescents. The general analysis showed that the impact of digital media on the aggressive behavior of adolescents in single-parent families is shaped by the family environment, the level of social monitoring, and individual characteristics. The escalation of aggression depends not only on the content of the media but also on the context in which it is perceived.

Discussion. The analysis of the study results showed that understanding the impact of digital media on adolescent aggressive behavior requires a multi-level theoretical approach. When interpreting this issue, the social learning theory (Bandura & Walters, 1977) and the general model of aggression (Anderson & Bushman, 2002) were used as methodological frameworks. According to social learning theory, adolescents acquire behavioral patterns through observation, imitation, and reinforcement. Elements of

violence in digital media, verbal aggression, deviant narratives, and aggressive scenarios in the gaming environment can enhance the process of normalizing aggression. The general model of aggression explains aggression as a result of the interaction between individual and situational factors. From this perspective, digital media can be viewed as a situational trigger, while psychoemotional instability in single-parent families, weakened parental control, or insufficient emotional support can be considered as individual vulnerability factors. In other words, aggression does not arise directly from digital content but rather develops as a result of interactions with personal and social factors. Recent empirical studies support this theoretical framework, indicating that cyberbullying develops as a learned behavior influenced by both individual and environmental factors (Barlett, 2023; El Mezayen et al., 2025). Additionally, the situational action perspective highlights the interplay between contextual and individual factors in explaining adolescents' involvement in cyberbullying (Hu et al., 2024). This theoretical framework provides a solid platform for discussing the protective role of parental mediation and other interventions in preventing cyberbullying.

Research shows that parental digital mediation strategies play a crucial role in regulating adolescents' online behavior. Parental monitoring, guidance, and modeling contribute to the safe use of digital technologies and serve as key factors in preventing online aggression. Consequently, the level of parental mediation, particularly in two-parent and single-parent families, is considered an important socio-educational factor that directly influences adolescents' behavior in the digital environment (Navarro et al., 2023). Consistency between shared parenting styles and digital mediation strategies reduces the risk of cyberbullying, while inconsistency increases this risk (Rega et al., 2022).

Empirical studies conducted by researchers show that cyberbullying poses a significant risk to the psychological and social well-being of adolescents. Adolescents who have been victims of cyberbullying often exhibit signs of depression, anxiety, loneliness, and suicidal behavior. Moreover, adolescent aggressors involved in cyberbullying tend to display higher levels of aggressive behavior, deviant actions, and difficulties in social adaptation (Nixon, 2014). Recent studies show that the widespread use of social media by teenagers often puts them at risk of becoming victims of cyberbullying. For example, a study conducted in Indonesia found that 69% of teenagers had experienced bullying on social media, while the majority continued to use these platforms. This highlights the potential long-term impact of the digital environment on the psychological well-being and behavior of teenagers (Milyane et al., 2025).

Cyberbullying is a specific form of bullying that takes place in the digital environment and has a widespread impact on students (Wong-Lo and Bullock, 2011). Traditional bullying, cyberbullying, and other forms of interpersonal violence are closely interconnected during adolescence. Psychosocial factors such as low moral responsibility, peer pressure, and inadequate emotional regulation skills contribute to the development of aggressive behavior. Identifying these factors is crucial for preventing aggression in the digital space and promoting safe digital behavior among adolescents (Sánchez-Jiménez et al., 2023). The use of digital technologies and devices has become a major source of conflict between parents and children. The main factors contributing to this include excessive time spent by teenagers online, access to inappropriate content, the impact of digital media on behavior, and disagreements between family members. Additionally, differences in the perception of digital technology between parents and children can exacerbate family conflicts (Page Jeffrey, 2024).

In single-parent families, limited access to parental resources can exacerbate the impact of digital media. However, some studies also suggest that the digital environment can serve as a compensatory function. Online communities can provide social support and reduce feelings of isolation. Therefore, digital media should be viewed not only as a risk factor but also as a double-edged sword. In the context of Kazakhstan, the increased availability of the

internet, widespread use of social media, and the rise of online gaming culture have led to an increase in the amount of time spent by teenagers in the digital realm. In addition, changes in urbanization, labor migration, and divorce rates have led to an increase in the number of single-parent families. This situation highlights the social significance of the impact of digital media. Thus, the relationship between digital media and adolescent aggression is non-linear, complex, multifactorial, and context-dependent. In the formation of aggression, it is not only the content of digital media that plays a crucial role, but also the family structure, psycho-emotional conditions, and social environment factors. However, most researchers have shown that active parental involvement and digital technology sharing strategies reduce the risk of adolescents being involved in cyberbullying (Lee et al., 2022). Therefore, policies aimed at preventing adolescent aggression should prioritize not only restrictive measures and monitoring, but also the development of media literacy, improving parents' digital competence, and strengthening psychological support systems.

Conclusion. The results of the study show that the impact of digital media on the aggressive behavior of adolescents from single-parent families is complex, multifactorial, and context-dependent. An analysis of international empirical studies indexed in the Scopus database from 2000 to 2025 led to the following conclusions:

1. Aggressive content in digital media, cyberbullying, and elements of violence in online games are important factors that contribute to the development of aggressive behavior in adolescents.

2. In single-parent families, a lack of emotional support and low parental control increases the impact of digital media. Family structure becomes a key factor in preventing the development of adolescent aggression.

3. The development of aggression is not limited to media-related factors; mediating factors include media literacy, self-regulation skills, and peer influence.

4. In Kazakhstan, the influence of digital media is related to urbanization, labor migration, and the growing number of single-parent families. These factors can increase the involvement of adolescents in the virtual environment and contribute to the development of aggressive behavior.

The influence of digital media in the socio-psychological context of single-parent families can contribute to the prevention of aggressive behavior among adolescents by comprehensively studying the influence of digital media, conducting a systematic analysis of the interaction between media, personal, and social factors in the formation of adolescent aggression. The results of this research can be used in the organization of educational, psychological, and social activities. Recommendations include the implementation of targeted media literacy programs, enhancing parental skills in digital monitoring, and developing guidelines for online safety. As a limitation, the study did not conduct an independent empirical study; the results are based on a synthesis of international studies. Future research should focus on collecting empirical data in the Kazakhstani context to more accurately assess the impact of digital media on adolescent aggression.

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Original Article

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Formation of Media Literacy in Future Teachers of Preschool Organizations

Abstract

Introduction. The study addresses the problem of media literacy development among pre-service teachers of preschool education within the context of professional training. The relevance of the topic is driven by the growing role of the digital media environment in the lives of preschool-aged children and the insufficient preparedness of students to engage in media education activities. *Methodology and Methods*. A survey was conducted among 41 third-year students enrolled in the Preschool Education and Upbringing Programme at the University. The research instrument was a closed-ended questionnaire designed to diagnose students' perceptions of media literacy as a professional competency of a preschool teacher. *Results.* It was found that the majority of respondents generally recognize the professional significance of media literacy; however, they demonstrate reductive perceptions of its cognitive dimension and tend towards a restrictive model of media upbringing. A persistent conflation of the technical and cognitive components of media literacy was identified, along with insufficient readiness among students to conduct media literacy outreach work with families of pupils. *Scientific Novelty*. Empirical data have been obtained on pre-service preschool teachers' perceptions of media literacy as a professional competency within the contemporary information and media environment. *Practical Significance*. The findings of the study may be applied in designing the content of professional cycle disciplines, developing teaching placement programmes, and creating diagnostic instruments for assessing the media literacy of student teachers.

Keywords: media literacy, pre-service preschool teachers, professional training, digital competency, media upbringing.

Introduction. The rapid digitalization of all spheres of social life has necessitated the development of media literacy (Share, 2009) as a fundamental professional competency of educators, including within the preschool education system. The contemporary child becomes embedded in the media environment from an early age, which places fundamentally new demands on the professional readiness of preschool teachers to work in a digitally saturated environment. Media literacy represents an integrative personal competency that encompasses the ability to purposefully search for, critically analyze, and objectively evaluate information presented in various media formats, including textual, audiovisual, digital, and multimedia forms, as well as the capacity to create original media content with an understanding of the mechanisms that shape the contemporary information and communication environment (Von Gillern et al., 2024). A media-literate individual (Yeleussiz & Qanay, 2025) is not a passive consumer of media products: they are capable of recognizing manipulative techniques of influence, verifying the credibility of sources, interpreting the implicit meanings of media messages, and consciously resisting information-related risks. Furthermore, media literacy presupposes the formation of an ethically responsible attitude towards the production and dissemination of information in the digital space, including

adherence to netiquette norms, respect for intellectual property rights, and awareness of the social consequences of media communication. In a broader sense, media literacy (Von Gillern et al., 2022) constitutes a necessary condition for the full and safe participation of the individual in the life of the information society, ensuring not only protection from destructive media influence but also the possibility of creative, critical, and responsible engagement with the media environment.

No single definition of media literacy has been established within the scholarly community that commands broad consensus. Nevertheless, several key researchers have made foundational contributions to the conceptualization of the subject. The definition formulated by Aufderheide (2018), following the National Leadership Conference on Media Literacy, is widely regarded as the starting point for most contemporary definitions. The researcher characterized media literacy as the ability to access, analyze, evaluate, and communicate messages in a wide variety of forms. This formulation set the conceptual tone for the understanding of the subject among subsequent scholars (Christ & Potter, 1998; Hobbs & Jensen, 2016). A significant influence on the development of Western media education theory was exerted by the British scholar Masterman (2003). In his conceptual framework, the goal of media education was not limited to the development of critical thinking: the scholar insisted on the necessity of cultivating "critical autonomy" in the individual - that is, the capacity to independently and autonomously make sense of media messages (Masterman, 2003). A similar interpretation was proposed by Kubey (2001), who viewed media education as a tool for enabling students to understand how and why media function.

A substantial contribution to the development of media literacy theory was made by Hobbs (2010), who developed the AACRA model comprising five interrelated components: access, analysis, create, reflect, and act. Within this framework, media literacy is conceptualized as an expanded form of personal literacy that synthesizes the approaches of media literacy, information literacy, visual literacy, and new literacies (Hobbs, 2010). Thus, despite the diversity of approaches, a general tendency can be observed in scholarly discourse towards understanding media literacy as an integrative competency that presupposes not only the reception of media messages but also the active and purposeful participation of the individual in the media environment. In the context of the professional training of pre-service preschool teachers, media literacy acquires a multilevel and multifunctional character, necessitating its examination through the lens of three interrelated dimensions of professional competency.

The personal dimension characterizes the internal, subjective plan of the teacher's media literacy and presupposes the formation of a stable system of skills for perceiving media information. Within this dimension, particular significance attaches to the teacher's capacity for conscious and reflective evaluation of media messages received through various communication channels - traditional mass media, digital platforms, social networks, and multimedia resources. A key aspect is the formation of analytical strategies for information verification: the ability to recognize manipulative techniques in the presentation of material, identify concealed ideological orientations in media texts, and differentiate credible content from disinformation and fabricated messages. Equally important is the development of a stable media hygiene in the teacher: a conscious and selective approach to media content consumption which directly influences the formation of professional values and worldview orientations. The personal dimension of media literacy serves not only a protective function with respect to the teachers themselves but also constitutes a necessary foundation for the realization of subsequent professional functions, since only a teacher possessing a well-developed media culture of their own is capable of purposefully and competently conducting media education activities with preschool children (Hobbs et al., 2018; Ramasubramanian et al., 2025).

The professional-didactic dimension reflects the operational plan of media literacy and reveals

the teacher's competency in the pedagogically grounded selection, adaptation, and application of media tools within the educational process with preschool-aged children. The substantive content of this dimension is determined by competency in selecting audiovisual content and digital educational resources that meet the age-related, psychophysiological, and individual characteristics of pupils: the teacher must be able to evaluate media materials in terms of their educational value, emotional safety, and compliance with sanitary and hygiene requirements governing the use of screen technologies in work with young and preschool-aged children. In addition, the professional-didactic dimension presupposes command of methods for integrating digital tools into the developmental educational environment of the preschool organization: designing media education situations, developing didactically grounded media-based materials, and organizing productive media activities for children in accordance with the principles of preschool didactics. An important place is occupied by the teacher's capacity for methodological reflection on the outcomes of media tool application and critical evaluation of their influence on the cognitive, speech, social-personal, and artistic-aesthetic development of pupils. The professional-didactic dimension of media literacy ensures an organic interconnection between the teacher's media competency and the specific objectives of the educational process in the kindergarten setting (Daneels & Vanwynsberghe, 2017).

The outreach dimension reveals the translational plane of media literacy, and characterizes the teacher's ability to purposefully cultivate the foundations of media literacy among the subjects of the educational process - both preschool-aged children and their parents. This dimension presupposes the implementation of media education activities in accessible and age-appropriate forms: through play-based situations, joint productive activities, organized discussions about the media environment and rules of safe behavior within it, and the gradual formation in pupils of elementary skills for distinguishing the real from the virtual and understanding the constructed nature of media images. With respect to working with families, the outreach dimension entails equipping parents with knowledge about the risks of uncontrolled media consumption by children, strategies for family-based media upbringing, and methods of conscious shared use of digital resources. The realization of the outreach dimension requires the teacher not only well-formed communicative competencies but also a readiness to act as a subject of media-cultural education within the community, which corresponds to the expanded understanding of the professional role of the preschool teacher in the context of the digitalization of the social environment (Yeleussiz & Qanay, 2025).

Thus, the media literacy of a pre-service preschool teacher cannot be reduced to a set of discrete skills or a personal quality but rather constitutes an integrative, professionally significant competency structured around three mutually complementary dimensions. The unity of the personal, professional-didactic, and outreach dimensions determines the teacher's capacity to fulfil a threefold function: a protective function - shielding children from destructive media content; a developmental function - employing digital technologies as an instrument of the preschool child's personal and cognitive development; and a culture-forming function - laying the foundations of an individual's information culture from the earliest age. This understanding of media literacy is consistent with contemporary conceptions of professional pedagogical competency and responds to the strategic objectives of modernizing the preschool education system in the context of the digital transformation of society.

Materials and Methods. *Research design*. This study employed a quantitative descriptive research design. A survey-based approach was selected as the most appropriate method for diagnosing levels of media literacy awareness, perceptions, and professional attitudes among pre-service teachers within a clearly defined population. The cross-sectional design enabled the collection of empirical data at a single point in time, facilitating the identification of current patterns in respondents' understanding of media

literacy across three key dimensions: personal, professional-didactic, and outreach.

Participants. The study was conducted among pre-service preschool teachers enrolled at Abai Kazakh National Pedagogical University (Almaty, Kazakhstan). The target population consisted of full-time third-year undergraduate students pursuing the 6B012 Preschool Education and Upbringing Programme. A total of 41 students participated in the study. Third-year students were deliberately selected for two reasons. First, by this stage of their Programme, they have completed the core professional disciplines of the curriculum. Second, they have accumulated direct experience through supervised teaching placement, which positions them to consciously and critically reflect on their readiness to integrate media literacy into professional practice. The sample was formed using a census method applied within several designated study groups, ensuring homogeneity of respondents in terms of level of training, Programme profile, and stage of professional preparation. No exclusion criteria were applied, as all students within the selected groups met the eligibility requirements.

Data collection instrument. A structured, standardized questionnaire was developed as the primary data collection instrument. The questionnaire comprised four closed-ended items, each offering four fixed response options (one correct and three distractors). The instrument was designed to measure three theoretically grounded dimensions of media literacy in pre-service preschool teachers:

1) Personal dimension - the respondent's individual media consumption habits and critical awareness of media content;

2) Professional-didactic dimension - knowledge and readiness to incorporate media literacy into educational activities with preschool-age children;

3) Outreach dimension - capacity to engage and communicate with parents and the broader community on issues of media literacy.

For each item, one response option reflected a professionally grounded, pedagogically sound position on media literacy, while the remaining three options represented typical misconceptions or superficial understandings of the concept under investigation. This design allowed the researchers to diagnose not only respondents' correct knowledge but also the nature and pattern of their misconceptions. Content validity of the questionnaire was ensured through alignment of all items with the theoretical framework of the study. Before administration, the instrument was reviewed by subject-matter specialists in the field of preschool pedagogy and media education.

Data collection procedure. The survey was administered in a face-to-face, paper-based format under standard classroom conditions during regularly scheduled sessions. This format was chosen to ensure the independence of each respondent's answers and to preclude any possibility of mutual influence or consultation among participants during questionnaire completion. Participation was entirely voluntary and anonymous. Before the survey commenced, all participants were informed of the aims of the study, the confidentiality of all data collected, and their right to withdraw without consequence. Written information regarding these conditions was provided at the top of the questionnaire form. No identifying information was collected. Completion of the questionnaire required no more than 15 minutes**.**

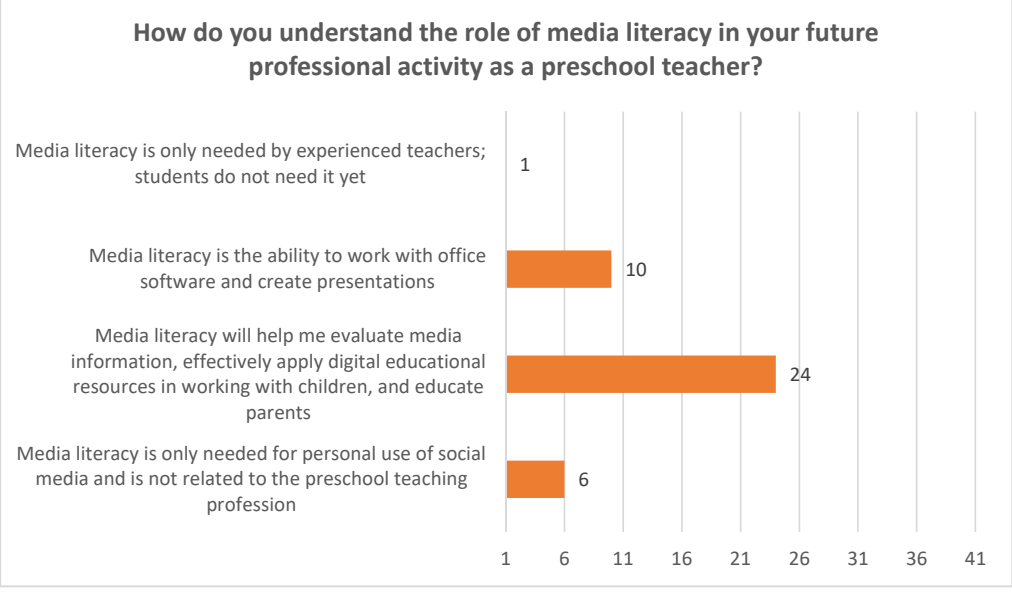
Data analysis. Quantitative data obtained from the completed questionnaires were analyzed using descriptive statistics. For each of the four items, the frequency and percentage distribution of responses across all four options were calculated. The proportion of respondents selecting the correct answer (the professionally grounded position) was used as the primary indicator of competence within each measured dimension of media literacy. Results were aggregated across dimensions to produce an overall profile of the cohort's media literacy awareness. Where relevant, patterns of incorrect response selection were examined to identify recurring misconceptions. Data were processed using Microsoft Excel. All results are reported as absolute frequencies and percentage shares of the total sample (n=41).

Results. The data obtained were subjected to quantitative processing: for each question,

the percentage of respondents selecting each response option was calculated. The results were analyzed (Figures 1–4) across the three identified dimensions of media literacy with the aim of determining the level of formation of the corresponding perceptions among pre-service preschool teachers and identifying the most problematic aspects requiring targeted intervention within the framework of professional training.

Figure 1

Distribution of respondents' answers to the question on the role of media literacy in the professional activity of a preschool teacher (n=41)

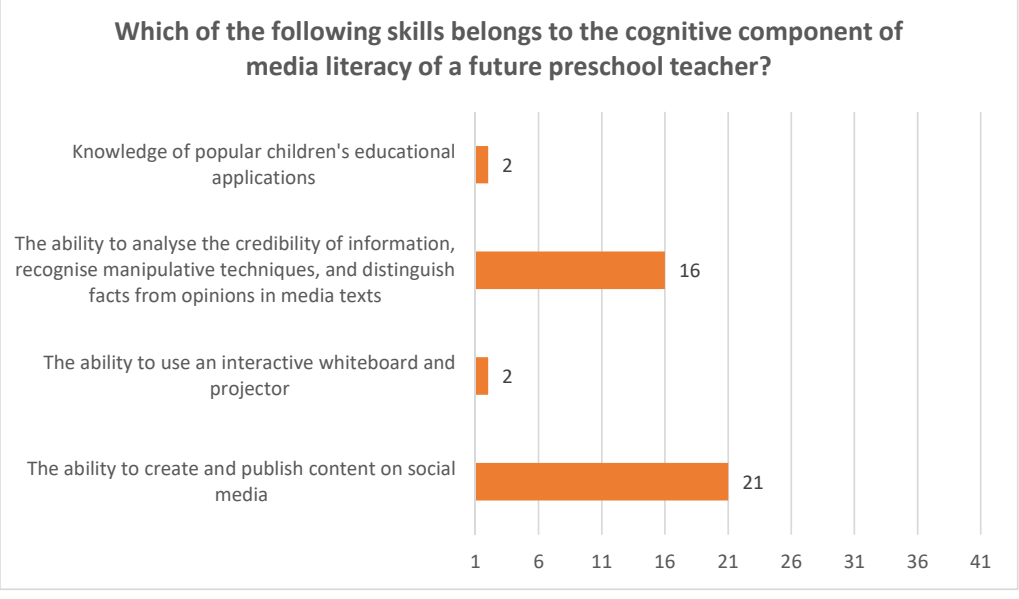


The survey results for the first question reveal heterogeneity in students' perceptions of the professional role of media literacy (Figure 1). The professionally grounded position - understanding media literacy as an instrument for evaluating media information, competently applying digital educational resources, and conducting outreach work with parents - was selected by 24 respondents, accounting for 58.5% of the sample. This considerable figure suggests that more than half of pre-service teachers recognize the multidimensional, professionally oriented nature of media literacy, which may be attributed to their completion of disciplines within the psychological-pedagogical cycle and their teaching placement experience.

At the same time, a substantial proportion of students demonstrated a reductive understanding of the phenomenon. Thus, 10 respondents (24.4%) equated media literacy with proficiency in office software and presentation design skills, pointing to a persistent conflation of the concepts of "media literacy" and "digital literacy". This tendency is characteristic of students whose familiarity with digital technologies is largely confined to the use of application software for academic purposes. Six students (14.6%) regarded media literacy exclusively as a skill pertaining to the personal consumption of social media, failing to recognize its connection to professional activity, thereby reflecting an insufficient appreciation of the translational and outreach functions of the teacher in the contemporary information environment. Only one respondent (2.4%) held the view that media literacy is irrelevant for students, considering it necessary only for experienced teachers - a position that reflects an orientation towards deferred professional development.

Figure 2

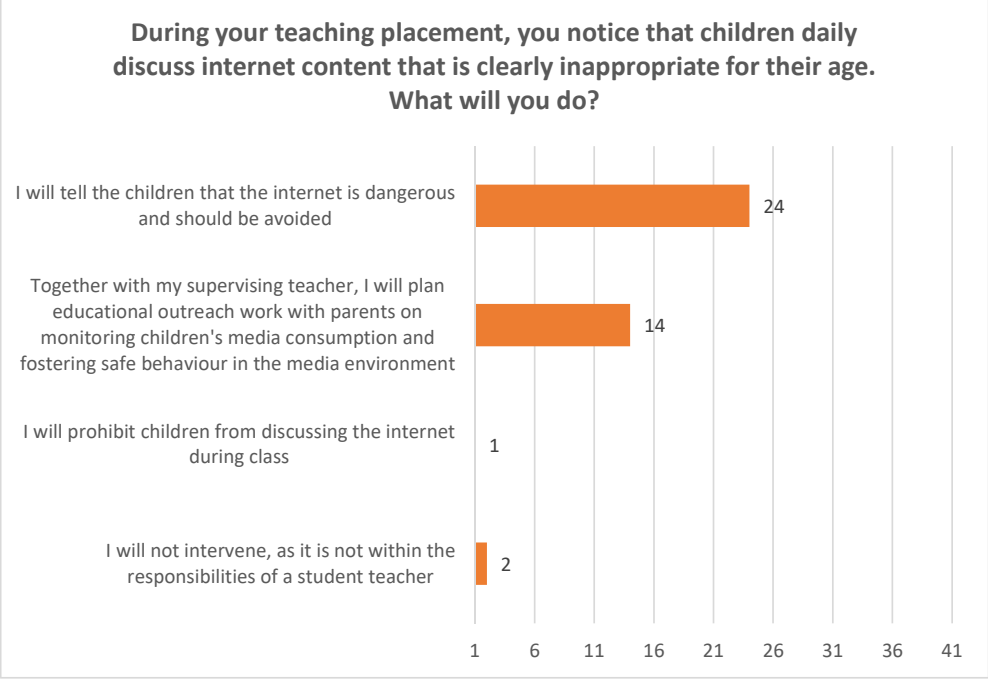
Distribution of respondents' answers to the question on defining the cognitive component of media literacy of a preschool teacher (n=41)



The responses to the second question reveal the most pronounced problem area in students' perceptions of the structure of media literacy (Figure 2). The correct answer - the ability to analyse the credibility of information, recognize manipulative techniques, and distinguish facts from opinions in media texts - was selected by only 16 respondents (39.0%), representing less than half of the sample. The majority of students - 21 persons (51.2%) - erroneously attributed to the cognitive component of media literacy the ability to create and publish content on social media. This result appears consistent with the prevalence of social media in the everyday lives of young people: students who actively create user-generated content tend to perceive this skill as the central element of media competency, without differentiating between the technical and cognitive levels of media literacy. An insufficient formation of theoretical understanding of the structural components of media literacy according to the classification proposed by R. Hobbs and other researchers is clearly discernible. Two respondents each (4.9% respectively) indicated options related to the use of an interactive whiteboard and knowledge of children's educational applications, reflecting an instrumental-technological interpretation of media literacy.

Figure 3

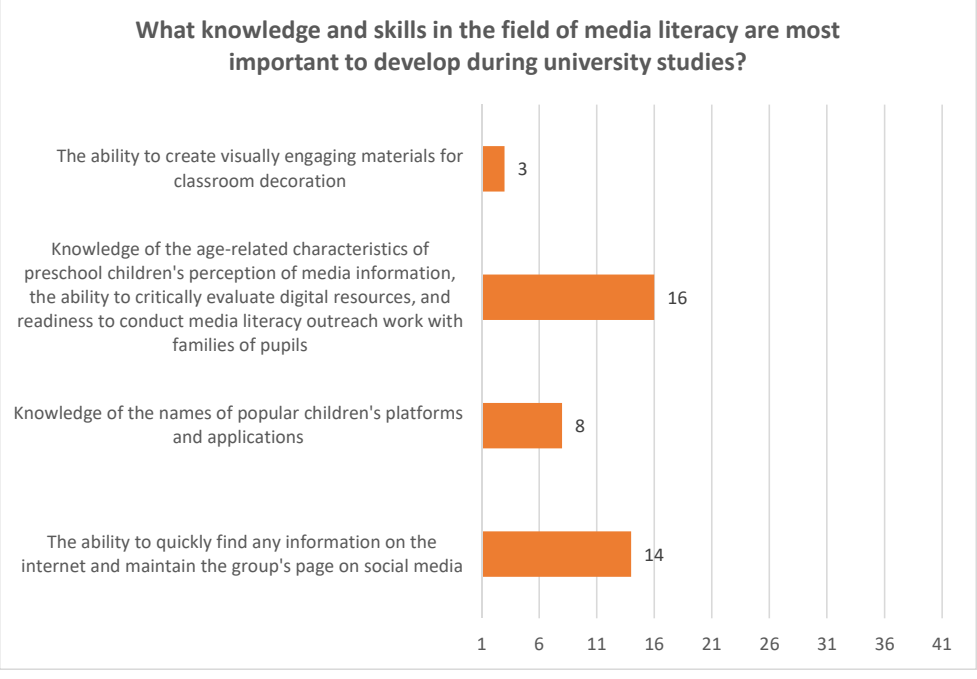
Distribution of respondents' answers to the situational question on responding to age-inappropriate media content among children during teaching placement (n=41)



The responses to the third question reveal the most pronounced divergence between the professionally grounded position and the actual attitudes of students (Figure 3). The correct answer - jointly planning with the supervising teacher an outreach Programme for parents on monitoring children's media consumption and fostering safe behavior in the media environment - was selected by only 14 respondents (34.1%). The predominant response was option D - informing children of the dangers of the internet and the need to avoid it - chosen by 24 students (58.5%). This remarkably high figure is of particular interpretive interest: it indicates that the majority of pre-service teachers tend towards a restrictive model of media upbringing, grounded in prohibition and deterrence rather than in the formation of critical engagement with media information. Such an orientation is attributable both to public discourses about internet threats that circulate widely in the media environment and to insufficient professional preparation in the field of media education technologies. It is important to emphasize that the strategy favored by the students contradicts the principles of media education, which presupposes not the isolation of the child from the media environment but rather the formation of skills for conscious navigation within it. Two students (4.9%) adopted a position of non-intervention, citing the limited authority of a student teacher - reflecting a passive professional stance in a situation that demands a pedagogical response. Only one respondent (2.4%) opted for prohibiting discussion of the internet during class - a response reflecting a restrictive yet less categorical strategy.

Figure 4

Distribution of respondents' answers to the question on priority knowledge and skills in the field of media literacy to be developed during university studies (n=41)



The responses to the fourth question reflect an instability in students' perceptions of the content of professional training in the field of media literacy. The professionally grounded answer - knowledge of the age-related characteristics of preschool children's perception of media information, the ability to critically evaluate digital resources, and readiness to conduct media literacy outreach work with families of pupils - was selected by 16 students (39.0%), which, while representing the largest share among all response options, nonetheless falls short of an absolute majority. Fourteen students (34.1%) favored the option associated with the ability to quickly find information on the internet and maintain the group's page on social media. This choice allows one to conclude that a considerable proportion of students reduce the professional media literacy of a teacher to the level of user skills characteristic of a non-professional audience - a tendency attributable both to an absence of clear understanding of the specifics of pedagogical media literacy and to the influence of everyday experience with digital platforms. Eight students (19.5%) identified knowledge of popular children's platforms and applications as the priority, reflecting an instrumental-technological orientation in the understanding of professional training that is devoid of a reflexive-critical dimension. Three students (7.3%) highlighted the creation of visual materials for classroom decoration, pointing to an equation of media literacy with the decorative and design-related activities of the teacher.

Discussion. The findings of the survey open avenues for a meaningful examination of the identified tendencies in the context of current international research on teacher media literacy. The finding that 58.5% of respondents generally recognize the professionally oriented nature of media literacy is consistent with the conclusions of Lähdesmäki and Maunula (2023), who, through qualitative analysis of opinion pieces produced by 37 student teachers at a Finnish university, established that pre-service teachers broadly identify media literacy as a significant competency necessary for fostering children's safe and responsible relationship with the media environment. The authors emphasize, however, that awareness of the significance of media literacy does not in itself guarantee readiness for

its practical implementation in the educational process - a disparity clearly discernible in the responses of the Kazakhstani students: despite their declared understanding of the professional role of media literacy, only 34.1% demonstrated the capacity for professionally grounded behavior in a concrete pedagogical situation (Question 3).

Particular attention is warranted by the tendency identified in the analysis of responses to the second question towards a conflation of the cognitive and technical dimensions of media literacy: 51.2% of students erroneously attributed to the cognitive component the ability to create and publish content on social media. This contradiction resonates with the concerns raised by Simons (2017) in a study devoted to the development of an instrument for measuring teachers' media competency: the author demonstrates convincingly that teachers frequently exhibit considerable discrepancies between individual components of media competency, particularly between technical literacy and the capacity for critical analysis of media content. The results of a factor analysis conducted on a sample of 454 teachers and 219 student teachers confirm the multidimensional nature of media competency and the necessity of its operationalization through a system of differentiated indicators.

Equally instructive are the results of the third question, according to which 58.5% of students adopted a restrictive strategy in responding to age-inappropriate media content, preferring to appeal to the dangers of the internet as such. Such an orientation stands in direct contradiction to the conceptual foundations of media education as consistently developed in the work of Hobbs and Tuzel (2017): examining the digital learning motivation profiles of 2,820 Turkish educators, the authors establish that teachers oriented towards the development of students' critical thinking demonstrate a markedly different professional stance, one of conscious navigation within the media environment rather than isolation from it. The predominance of the restrictive model in the responses of students at the Kazakhstani university may be explained by the absence of specialized courses from curricula that cultivate an understanding of media education as a positive developmental practice rather than a protective and restrictive measure.

In this regard, the question of the organizational forms through which media literacy is incorporated into teacher professional training is of considerable importance. Meehan et al. (2015) make a compelling case that the introduction of a standalone media literacy course within teacher education programmes is not always organizationally feasible; however, media literacy can be effectively integrated into existing disciplines as a cross-cutting pedagogical strategy. The authors emphasize the necessity of cultivating in pre-service teachers the habit of examining sources, reflecting on their own assumptions, and becoming aware of their own media habits as foundational professional competencies. It is precisely the absence of this reflexive dimension that is evident among the 61.0% of respondents who did not select the professionally grounded answer to the fourth question: the predominance of instrumental-technological priorities over reflexive-critical ones indicates that media literacy has not been integrated into a coherent professional worldview among a substantial proportion of students.

The totality of the results examined allows for the formulation of several conclusions of significance for the improvement of professional training for preschool teachers in Kazakhstan. First, a clear differentiation of the technical, cognitive, and outreach components of media literacy within curricula is required - as proposed in the instrument developed by Simons (2017). Second, professional training must encompass not only theoretical familiarization with the concept of media literacy but also the practical rehearsal of professional response scenarios in situations involving children's and parents' media consumption, in accordance with the principle of shared educational responsibility between school and family as substantiated by Lähdesmäki and Maunula (2023). Third, drawing on the conclusions of Hobbs and Tuzel (2017) regarding the significance of teachers' motivational profiles, professional training

programmes should provide for the diagnosis of students' attitudes towards media education and targeted work to overcome restrictive stereotypes that impede the realization of the developmental potential of the media environment in the education of preschool-aged children.

Conclusion. The problem of developing media literacy among pre-service preschool teachers is gaining increasing relevance in the context of the rapid digitalization of the developmental environment and the pervasive involvement of preschool-aged children in the media space. Analysis of the responses of 41 students revealed a contradiction that characterizes the current state of professional training in the field under investigation: the declarative recognition of the significance of media literacy among the majority of respondents is not supported by an operational readiness for its practical implementation.

A considerable proportion of pre-service teachers equate professional media competency with user-level digital skills, failing to recognize its critical-analytical and outreach potential. Equally concerning is the predominance of a restrictive model of media upbringing, in which the pedagogical response to media-related risks is reduced to prohibition and deterrence rather than the formation in children of skills for conscious and safe navigation of the media environment. The identified problems cannot be resolved through isolated instructional activities and require a purposeful revision of the content of professional training for preschool educators. In this regard, it is reasonable to put forward several recommendations aimed at improving the media literacy preparation of pre-service preschool teachers. Curricula for the 6B012 Programme should provide for a consistent differentiation of the technical, cognitive, and outreach components of media literacy, ensuring the formation in students of a coherent professional understanding of the phenomenon. The theoretical acquisition of the conceptual framework of media education must be combined with practice-oriented tasks that simulate real pedagogical situations involving children's media consumption and interaction with families of pupils. The prospects for further research lie in broadening the sample to include students across different years of study and pedagogical programs, as well as in the development and pilot testing of media literacy formation programs for preschool teachers with subsequent evaluation of their effectiveness.

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Original Article

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Methodological Foundations of Meta-Competence Development in Future Educational Psychologists within Digital Learning Environments

Abstract

Introduction. The digital transformation of higher education has changed the professional preparation of future educational psychologists and requires competencies that go beyond the technical use of digital tools. This study aims to substantiate the methodological foundations for developing meta-competence in future educational psychologists within digital learning environments and to propose a conceptual model that reflects the professional specificity of psycho-pedagogical support. *Methodology and Methods.* The research is based on theoretical analysis, comparative interpretation of international competence frameworks, conceptual generalization of contemporary studies on digital competence and innovative professional behavior, and model construction. *Results.* The findings substantiate that digital technologies in the training of future educational psychologists should be conceptualized not merely as instructional tools but as a comprehensive environment of professional development. The article proposes an authorial model of the meta-competence structure of future educational psychologists in the digital educational environment. *The scientific novelty* of the study lies in the theoretical and methodological integration of international digital competence frameworks with the logic of meta-competence development of future educational psychologists. For the first time, the digital training of specialists in this profile is conceptualized not merely as the acquisition of digital literacy, but as the formation of innovation-oriented professional agency. The *practical significance* of the study lies in the applicability of the proposed model for the design of educational modules and courses, the development of assessment criteria, diagnostic rubrics, and tools for subsequent empirical validation in the system of training future educational psychologists.

Keywords: meta-competence, digital technologies, future educational psychologists, digital educational environment, digital competence, innovative professional behavior.

Introduction. The rapid digitalization of higher education is fundamentally changing the content, forms, and conditions of professional training for specialists in pedagogy and psycho-pedagogy. Contemporary educational environments include learning platforms, distance and blended learning systems, digital feedback tools, learning analytics, interactive services, and generative AI technologies, all of which require future specialists not only to possess technical literacy but also to act effectively under conditions of uncertainty, information overload, and technologically mediated interaction (Bond et al., 2018; Crompton & Burke, 2023; Lee et al., 2024; OECD, 2019; UNESCO, 2023).

International scholarship conceptualizes teachers' digital competence as a complex of knowledge, skills, and attitudes that enables meaningful use of technologies in teaching, assessment, interaction, and professional development (Redecker, 2017; Vuorikari et al., 2022). At the same time, contemporary frameworks such as DigCompEdu, LifeComp, and the OECD Learning Compass 2030 demonstrate that digital training cannot be reduced to instrumental mastery alone, but also involves the development of critical

thinking, reflexivity, responsibility, self-directed learning, and professional agency (OECD, 2019; Redecker, 2017; Sala et al., 2020; Sillat et al., 2021; Zhao et al., 2021). For future educational psychologists, this issue is particularly significant. Their professional activity is associated with psycho-pedagogical support, prevention, counseling, analysis of educational situations, maintenance of psychological safety, and adherence to ethical norms. Consequently, digital technologies in their training should not be treated as an external supplement to professional education, but as a specific environment in which higher-order integrative qualities are formed, namely, meta-competences that ensure the capacity for reflexive analysis, professionally responsible choice, communicative flexibility, support design, and innovative problem solving (Falloon, 2020; Sillat et al., 2021).

An equally important trend in contemporary literature is the growing recognition of the relationship between digital competences and teachers' innovative professional behavior. Studies on digital competence focus on technology use, pedagogical integration, and diagnostic frameworks, whereas studies on innovative work behavior emphasize self-efficacy, engagement, supportive environments, organizational climate, and readiness to generate and implement new ideas (Atatsi et al., 2022; Basilotta-Gómez-Pablos et al., 2022; Dixit & Upadhyay, 2021; Jia et al., 2022). In the context of training future educational psychologists, this connection is crucial: digital competence acquires real professional value only when it becomes a resource for designing, adapting, and implementing new psycho-pedagogical practices (Amhag et al., 2019; Ley et al., 2022; Domínguez et al., 2020).

Despite the growing interest in the digital transformation of education, the problem of meta-competence development in future educational psychologists through digital technologies remains insufficiently elaborated. A gap persists between general digital competence frameworks and the professional specificity of helping practices, where ethicality, reflexivity, psychological safety, the quality of data interpretation, and readiness for innovation-oriented professional action are decisive (Ng et al., 2021; Timotheou et al., 2023; Zhao et al., 2021). This article aims to provide a theoretical and methodological substantiation for the meta-competence development in future educational psychologists through digital technologies and to propose an authorial model of its structure and levels of formation.

Materials and Methods. The study is theoretical-methodological and conceptual-modeling in nature. Its design is not aimed at testing a specific empirical hypothesis, but at identifying and systematizing the methodological foundations for the meta-competence development in future educational psychologists under conditions of a digital educational environment.

The material of the study included: international frameworks of digital, personal, and educational competences; studies devoted to teachers' digital competence in higher education; studies on innovative professional behavior in educational contexts; publications on teacher agency, AI literacy, data literacy, digital citizenship, professional self-efficacy, and teachers' reflexive development (Basilotta-Gómez-Pablos et al., 2022; Jia et al., 2022; Mishra & Koehler, 2006; Redecker, 2017; Sala et al., 2020; UNESCO, 2023; Vuorikari et al., 2022).

The methodological framework of the study combines several complementary approaches. The competence-based approach makes it possible to interpret the outcomes of professional training as the ability to act in real and variable professional situations. The meta-competence approach shifts the focus from isolated skills to integrative mechanisms of professional thinking, self-regulation, and the transfer of action patterns to new contexts. The systems-activity approach makes it possible to understand competence development as a result of students' participation in various forms of educational and quasi-professional activity. The learner-centered approach emphasizes the subjective nature of professional becoming and the role of reflexivity, self-development, and conscious choice of professional strategies.

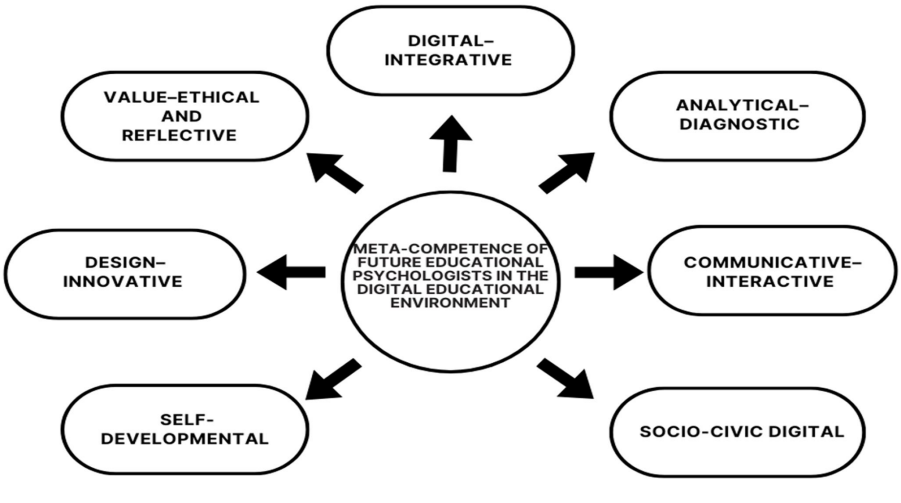
The study employed the following methods: theoretical analysis and synthesis of psychological-pedagogical literature; comparative analysis of international frameworks for digital and metacompetence-oriented training; conceptual generalization of contemporary research on digital competence and teachers' innovative behavior; modeling of the structure of meta-competence of future educational psychologists in the digital educational environment. The research was conducted in three stages. At the first stage, scientific sources and international frameworks were analyzed in order to identify contemporary approaches to digital competence, personal and social competences, teacher agency, and innovative professional behavior (Damșa et al., 2021; Jia et al., 2022; Redecker, 2017; Sala et al., 2020). At the second stage, the identified approaches were compared in order to determine those components that are most significant, specifically for the training of future educational psychologists. At the third stage, an authorial structural model of meta-competence and a rubric of its levels of formation were developed.

The choice of this design is conditioned by the current state of the research field itself. Contemporary reviews show that studies on teachers' digital competence are predominantly based on cross-sectional self-report designs, whereas studies on innovative behavior emphasize psychosocial and organizational factors but rarely integrate the digital dimension into a unified explanatory model (Basilotta-Gómez-Pablos et al., 2022; Dixit & Upadhyay, 2021; Jia et al., 2022). Under these conditions, a theoretical-methodological study aimed at conceptually integrating both lines of inquiry constitutes a justified and productive step toward future empirical operationalization of the proposed model.

Results. The results of the theoretical-methodological analysis make it possible to conceptualize the meta-competence of the future educational psychologist as an integrative system formed at the intersection of digital literacy, professional reflexivity, ethical responsibility, analytical thinking, communicative maturity, and readiness for innovative professional action. Unlike broader models of digital competence that focus primarily on the teacher as a user of technologies, the proposed model takes into account the specificity of psycho-pedagogical support, in which technologies mediate not only learning, but also trust-based interaction, diagnosis, prevention, data interpretation, and the maintenance of psychological safety. Figure 1 presents the authorial model of the structure of meta-competence of future educational psychologists in the digital educational environment.

Figure 1

Meta-competence of future educational psychologists in the digital educational environment meta-competence



Based on integrating the provisions of DigCompEdu, TPACK, SAMR, LifeComp, the OECD Learning Compass 2030, and contemporary studies on teachers' digital competence and innovative behavior, seven structural components of the meta-competence of future educational psychologists were identified (Jia et al., 2022; Mishra & Koehler, 2006; Redecker, 2017; Sala et al., 2020; Vuorikari et al., 2022). This selection is also consistent with the SAMR logic of technology integration (Puentedura, 2013): value–ethical and reflective; digital integrative; analytical diagnostic; communicative interactive; design–innovative; self-developmental; socio-civic digital. Accordingly, the structure of meta-competence of future educational psychologists in the digital educational environment should be understood as an integrative system of interrelated components, including value-ethical, digital-integrative, analytical-diagnostic, communicative-interactive, design-innovative, self-developmental, and socio-civic dimensions (Table 1).

Table 1

Structure of meta-competence of future educational psychologists in the digital educational environment

Metacompetence Component	Content	Digital Technologies and Means of Formation	Indicators of Formation
Value-ethical and reflexive	Evaluates digital practices from the perspective of professional ethics, psychological safety, confidentiality, reliability of information, data protection, and learners' well-being; includes readiness for reflection on one's own decisions in the digital environment	LMS platforms with privacy settings, digital cases on ethical dilemmas, professional situation simulators, reflective tools, and AI services for critical response analysis	Recognizes ethical risks of the digital environment; maintains confidentiality; critically evaluates content; justifies professional decisions; demonstrates a reflexive position
Digital-integrative	Meaningfully integrates digital resources into diagnosis, counseling, prevention, correctional-developmental, and psycho-educational activity	Moodle, Teams, Zoom, interactive boards, online questionnaires, digital psycho-educational resources, VR/AR scenarios, support platforms	Selects digital tools according to professional tasks; integrates technologies into support practice; adapts digital means to age and context
Analytical-diagnostic	Collects, interprets, and ethically uses data on learning progress, behavior, engagement, difficulties, and learners' needs; applies data to substantiate psycho-pedagogical decisions	Electronic journals, learning analytics, online diagnostics, feedback forms, digital observation cards, dashboards, data visualization tables	Interprets data and identifies significant indicators; sees risks and resources; uses results for targeted support; takes into account the limitations of digital diagnostics
Communicative-interactive	Builds empathic, inclusive, psychologically safe interaction in the digital environment, supports educational participants, moderates online communication, and prevents communicative risks	Videoconferencing tools, support chats, forums, shared documents, group-work platforms, and digital counseling scenarios	Maintains dialogue and feedback; conducts online communication within professional boundaries; prevents communicative risks; observes netiquette; creates an atmosphere of trust.

Design-innovative	Develops, adapts, promotes, and implements new digitally mediated forms of psycho-pedagogical work; generates ideas and creates innovative solutions in support, prevention, and development	Course design tools, authorial online modules, digital simulators, VR/AR, support chatbots, interactive cases, visualization services, digital storytelling, collaborative design platforms	Generates new ideas; adapts digital solutions to the context; develops original classes, cases, and modules; justifies the need for innovation; implements and evaluates outcomes
Subject-developmental	Includes self-organization, self-regulation, professional self-efficacy, continuous self-renewal, mastery of new technologies, resilience to change, and readiness for innovative professional activity	E-portfolios, digital reflective diaries, MOOCs, webinars, professional online communities, self-assessment tools, and individual planning instruments	Sets goals for professional growth; monitors personal progress; masters new digital practices; demonstrates independence, self-efficacy, resilience, and readiness for change
Socio-civic digital	Involves responsible participation in digital professional communities, promotion of psychological safety culture, media literacy, and digital citizenship; readiness for collaboration and professional interaction in the digital environment.	Professional online communities, psycho-educational platforms, social networks, publication services, collaborative project platforms	Participates in professional network communities; disseminates appropriate psycho-educational content; follows norms of digital citizenship; works collaboratively; promotes responsible attitudes toward the digital environment

The content analysis showed that the value-ethical and reflexive component has system-forming significance. For the future educational psychologist, the digital environment is not neutral, since it is associated with confidentiality, trust, learner vulnerability, the proper interpretation of digital data, and responsibility for psychologically safe interaction. Therefore, digital competence in this professional field should be subordinated not to the logic of technological efficiency as such, but to the logic of professional ethics and the humanistic orientation of educational support (UNESCO, 2023; Vuorikari et al., 2022). A second significant result was the identification of the digital-integrative, analytical-diagnostic, and communicative-interactive components. These components reflect a transition from understanding digital technologies as tools for information transmission to understanding them as resources for support, analysis of educational situations, flexible interaction, and professionally grounded decision-making. This conclusion is consistent with studies emphasizing the importance of pedagogical technology integration, data literacy, online teaching agency, and the development of digital practices sensitive to context and learners' needs (Almerich et al., 2016; Cabero-Almenara et al., 2020; Damşa et al., 2021; Sandoval-Ríos et al., 2026).

Particular attention is given to the design–innovative component, as its inclusion in the model is justified by the fact that digital technologies do not automatically lead to innovation. Innovative effects emerge when the future specialist is able to generate new solutions, adapt them to environmental conditions, implement them, and critically evaluate the results. In this sense, digital competence becomes a resource for innovative behavior rather than an end in itself. This conclusion is in line with studies on innovative work behavior, where innovation is understood as a process of idea generation, promotion, and

implementation, dependent on self-efficacy, engagement, organizational support, and opportunities for professional experimentation (Atatsi et al., 2022; Dixit & Upadhyay, 2021; Jia et al., 2022).

Finally, the self-developmental and socio-civic digital components capture the personal and environmental perspective of meta-competence development. The future educational psychologist must not only master digital practices but also be prepared for continuous professional self-renewal, participation in network communities, adherence to digital citizenship norms, and the dissemination of responsible psycho-educational content. These components ensure the transition from individual mastery of technologies to stable professional agency in digital space (OECD, 2019; Sala et al., 2020; UNESCO, 2023). For the purpose of subsequent empirical validation of the model, three levels of meta-competence development were distinguished: low, medium, and high (Table 2).

Table 2

Criteria and levels of meta-competence development in future educational psychologists in the digital educational environment

Metacompetence Component	Low Level	Medium Level	High Level
Value-ethical and reflexive	Fragmentarily recognizes ethical risks of the digital environment; has difficulty assessing the reliability of content; and insufficiently considers confidentiality and psychological safety.	Understands basic ethical requirements of digital interaction; in typical situations observes norms of confidentiality and safety; demonstrates partial reflection on personal digital actions	Systematically evaluates digital practices from the standpoint of professional ethics; anticipates risks for learners; makes well-grounded decisions; demonstrates a stable, reflexive, and responsible position.
Digital-integrative	Uses digital tools episodically and mainly as a technical add-on; resource selection is accidental; the link with psycho-pedagogical tasks is weak.	Selects digital means according to particular professional tasks; can use platforms, services, and online resources in support and teaching; needs methodological support for complex integration	Meaningfully integrates digital technologies into diagnosis, prevention, counseling, and support; selects tools according to goals, age, and context; ensures pedagogical and psychological appropriateness of digital solutions.
Analytical-diagnostic	Experiences difficulties interpreting digital data; treats results formally; does not always recognize the limitations of digital diagnostics	Uses feedback data, observation, and platform activity for general assessment; can identify some learner difficulties and resources	Interprets data comprehensively by combining quantitative and qualitative indicators; takes into account the limitations of digital tools; uses results for targeted psycho-pedagogical support and intervention design
Communicative-interactive	Experiences difficulties organizing productive communication in the digital environment; does not always observe netiquette; weakly manages online interaction.	Maintains business-like and benevolent communication; uses digital feedback channels; generally observes norms of digital interaction	Creates psychologically safe and empathic digital communication; effectively moderates interaction; prevents communicative risks; supports inclusion, trust, and professional boundaries.

Design-innovative	Reproduces ready-made digital solutions without adaptation; weakly designs original formats of work; innovation is situational.	Adapts known digital tools to psycho-pedagogical practice; can develop particular elements of classes, cases, and preventive materials.	Designs new digital formats of support, prevention, and development; creates original cases, modules, simulators, and scenarios; transforms professional tasks rather than merely replacing tools
Self-developmental	Depends on external instructions; has difficulty with self-assessment and planning professional growth; is unstable under technological change.	Realizes the need for professional self-development; uses some self-learning opportunities; is capable of partial self-regulation and goal setting	Demonstrates pronounced agency; independently masters new technologies; systematically engages in professional reflection; sets and achieves developmental goals.
Socio-civic digital	Passively participates in the professional digital environment; does not always understand norms of responsible digital behavior and public professional representation.	Observes basic norms of digital citizenship; participates in professional online communities; can disseminate appropriate psycho-educational materials	Demonstrates a responsible professional position in digital space; participates in communities of practice; promotes the culture of psychological safety, media literacy, and ethical digital interaction

The proposed level model makes it possible to interpretmeta-competence development as a movement from fragmented and predominantly instrumental use of digital means to their meaningful, integrated, ethically regulated, and innovation-oriented implementation. In this process, growth is expressed not only in greater technical confidence but also in the development of reflexivity, agency, analytical thinking, communicative maturity, and the ability to design psychologically safe digital practices. Such an understanding corresponds to the international tendency to describe the development of teachers' digital competence as a dynamic transition from basic technology use to transformative and leadership-oriented practice (Redecker, 2017).

Discussion. The results confirm that the meta-competence development in future educational psychologists within the digital educational environment cannot be reduced to the mastery of isolated digital tools. Contemporary international frameworks and empirical studies demonstrate that teachers' digital competence is increasingly understood as a multidimensional system that combines technological, pedagogical, ethical, critical, and reflexive dimensions (Redecker, 2017; UNESCO, 2023; Vuorikari et al., 2022). However, for the profession of educational psychologist, this logic remains insufficient: the structure of training must also include psycho-pedagogical mechanisms for ensuring trust, safety, targeted support, and professionally grounded choice in technologically mediated environments.

The proposed model is aligned with studies showing that digital competence acquires real professional meaning only when it becomes a resource for transforming practice. Research on digital competence emphasizes technology integration, data literacy, AI literacy, inclusion, and teacher agency, whereas research on innovative work behavior points to the importance of self-efficacy, engagement, collaborative climate, and organizational support in fostering innovative behavior among educators (Cabero-Almenara et al., 2020, 2022; Chan & Lee, 2023; Damşa et al., 2021; Dixit & Upadhyay, 2021; Jia et al., 2022). In this respect, our model integrates both analytical lines and allows digital technologies to be interpreted as a condition for the formation of innovation-oriented professional agency (Ng et al., 2021; Ouyang & Jiao, 2021).

Particularly significant is the identification of the value-ethical and reflexive component as system-forming. For educational psychologists, this component determines the acceptable boundaries of using digital tools, the modes of interpreting data, and the choice of interaction strategies with learners. Whereas more general pedagogical models often emphasize the efficiency of digital integration, psycho-pedagogical training is centrally concerned with how the digital environment affects psychological well-being, trust, vulnerability, self-relation, and learners' agency. Thus, strengthening the ethical and reflexive dimension is not an optional addition but a methodological necessity (Bond et al., 2024; Lee et al., 2024; Ng et al., 2021). At the same time, the results highlight the importance of the design-innovative and self-developmental components. Contemporary literature on innovative work behavior shows that innovation does not arise automatically from technological mastery; rather, it is mediated by personal resources, motivation, self-efficacy, collaborative culture, and a supportive environment (Atatsi et al., 2022; Jia et al., 2022; Zargar et al., 2025). Applied to the training of future educational psychologists, this means that the digital educational environment should be organized in such a way that students not only master tools, but also engage in case-based problem solving, the design of new support formats, reflexive analysis of practices, and the collaborative construction of professional solutions.

Several methodological limitations should also be acknowledged. First, the study is theoretical-conceptual in nature and does not include empirical validation of the proposed model. Second, the identified levels of formation constitute an authorial analytical rubric and require expert review and testing in real educational practice. Third, the field of digital competence research remains characterized by a predominance of self-report instruments, which limits the ecological validity of conclusions and further confirms the need for mixed-methods, longitudinal, and multilevel studies (Basilotta-Gómez-Pablos et al., 2022; Maderick et al., 2016). In this regard, a promising direction for future research is the development of diagnostic tools that combine self-assessment, expert observation, analysis of digital products, and the solution of professional cases.

Conclusion. The study made it possible to provide a theoretical and methodological substantiation for the development of meta-competence in future educational psychologists through digital technologies as a multidimensional process of professional development in the digital educational environment. It was shown that digital technologies function not only as learning tools but also as an environment for the development of professional agency, ethical responsibility, analytical thinking, communicative maturity, and readiness for innovative professional action. It was established that the preparation of future educational psychologists requires moving beyond a narrowly instrumental understanding of digital competence. The proposed model comprises seven interrelated components: value-ethical and reflexive, digital-integrative, analytical-diagnostic, communicative-interactive, design-innovative, self-developmental, and socio-civic digital. Taken together, these components reflect both the professional specificity of helping activity and the contemporary challenges associated with the digital transformation of higher education.

The theoretical significance of the study lies in adapting international digital competence frameworks to the profile of the future educational psychologist and integrating these frameworks with the logic of innovation-oriented professional behavior. The practical significance lies in the possibility of using the proposed model in the design of educational modules, assessment criteria, and diagnostic tools in higher education. Further research perspectives include expert validation of the model, development of diagnostic instruments, empirical testing of the proposed levels of meta-competence development, and examination of the relationship between digital competence, self-efficacy, reflexivity, and readiness for innovative professional behavior in future educational psychologists.

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Original Article

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Preparing Future Educational Psychologists for Tutoring Support of Gifted Children

Abstract

Introduction. The study focuses on identifying the actual level of tutoring competencies formed among psychology students for working with gifted children, and on substantiating the feasibility of their purposeful development within university-level professional training. *Methodology and Methods*. At the theoretical level, an analytical review of domestic and foreign psychological and pedagogical literature on giftedness, tutoring, and professional training of educational psychologists was conducted. The empirical basis consisted of a pilot survey of 37 third-year students enrolled in a Pedagogy and Psychology program at a University. The questionnaire comprised four closed-ended items diagnosing awareness of tutoring support, understanding of gifted children's needs, self-assessment of professional readiness, and attitudes toward the necessity of specialized training. *Results*. A clear contradiction was recorded between students' intuitive understanding of the specific characteristics of gifted children and their actual unreadiness to apply tutoring technologies in practice. The overwhelming majority of respondents rated the existing training program as insufficiently ensuring the formation of the relevant competencies. *Scientific Novelty*. The theoretical foundations of tutoring support for gifted children have been systematized and analyzed for the first time within the context of professional training of educational psychologists. *Practical Significance*. The findings provide a rationale for the purposeful incorporation of tutoring competencies into professional training content and may be applied in designing specialized courses and programs aimed at building readiness among future educational psychologists for working with gifted children within higher professional education.

Keywords: gifted children, tutoring support, future educational psychologist, professional training.

Introduction. In the psycho-pedagogical tradition, "giftedness" is understood as a complex, dynamic property of the psyche that takes shape over the course of an individual's life and reflects their capacity to attain outstanding outcomes in one or several fields of activity relative to the general population (Kuznetsova, 2024). Renzulli's (2021) Three-Ring Model posits that giftedness emerges at the convergence of three interrelated clusters: intellectual ability exceeding the average, sustained motivational engagement with tasks, and a high level of creative thinking (Renzulli, 2023). Gardner (1993) expands this framework considerably by proposing the theory of multiple intelligences, which holds that outstanding abilities are not confined to academic performance but may be expressed across musical, spatial, bodily-kinesthetic, interpersonal, and other dimensions of human activity.

A theoretically significant feature of gifted children's development is its pronounced asynchrony, a pattern elaborated in Silverman's scholarship (Silverman, 1993). The core of this phenomenon consists of the fact that intellectual advancement in gifted children substantially outpaces their emotional maturation and social development. This imbalance generates acute intrapersonal tensions: a child may demonstrate remarkable success in solving cognitively

demanding problems while simultaneously struggling with peer relations, the regulation of emotional states, and the demands of social adjustment. Empirical research further highlights the characteristic combination of heightened emotional sensitivity, perfectionistic strivings, existential preoccupations, and a chronic experience of difference from agemates in this population (Delgado-Valencia, 2025). Taken together, these features position gifted children not as a privileged, self-sufficient group - as common stereotypes suggest - but as a psychologically vulnerable category requiring purposeful specialist intervention.

The distinctive developmental profile described above creates a fundamental mismatch with the logic of conventional mass schooling. When curricula are standardized, the instructional pace is oriented toward the average student, and reproductive modes of teaching predominate, gifted learners are subjected to chronic intellectual understimulation, experience progressive erosion of academic motivation, and, in a range of cases, develop concealed forms of maladaptive behavior. Scholarly evidence demonstrates that a considerable share of such students face a condition aptly described as "invisible giftedness," a state in which their capabilities remain largely unrealized owing to an inadequate fit between the educational setting and their genuine developmental needs (Baccassino & Pinnelli, 2023; Renzulli, 2023). Compounding this is the paradox of overabundance: when the range of a child's interests and talents is exceptionally broad, this very breadth may complicate rather than facilitate the construction of a coherent educational trajectory and the formation of a stable professional self-concept. These converging challenges make a compelling case for individualized, specialized forms of psychopedagogical accompaniment that can adapt the educational environment to the unique profile of each gifted learner and create conditions for their holistic personal growth.

Tutoring support represents a principled pedagogical response to the challenges outlined above, differing from conventional instruction in its foundational orientation, its methodological repertoire, and the qualitative character of the relationship it establishes with the learner (Zeng & Yung, 2025). As a recognized field of educational practice, tutoring has historical roots in the collegiate traditions of Oxford and Cambridge, where the tutor occupied the role of a personal academic mentor who guided students' intellectual and character formation over extended periods. Within the contemporary pedagogical discourse, tutoring support is conceptualized as a distinctive form of educational activity whose defining purpose is the individualization of learning: it is oriented toward uncovering and cultivating the learner's own educational motives and interests, identifying and mobilizing relevant resources for the construction of a personalized educational program, and progressively developing the learner's capacity for autonomous design of their developmental pathway (Iuzzini-Seigel et al., 2022). What fundamentally distinguishes a tutor from a subject-matter teacher is a reorientation of professional focus: rather than transmitting a body of knowledge, the tutor accompanies the learner's process of self-determination, creating conditions in which the student clarifies their own values, interests, and learning objectives.

In the context of work with gifted children, tutoring support acquires a distinctive content and functional profile (Phelp & Lewis, 2022). Its first function is to create conditions under which a child's latent potential can be recognized and developed in cases where the standard school environment fails to furnish adequate opportunities for this. Its second function is navigational: the tutor assists the student in structuring goals, establishing a hierarchy of priorities, and designing a realistic, personalized plan for their attainment. Its third function concerns psychological safety: the tutor cultivates an interaction space in which the learner is free to experiment, to err, and to reflect without the burden of evaluative judgment, thereby fostering constructive social engagement and supporting integration into broader educational and community life.

The professional demands that tutoring support of gifted children places on the educational psychologist are considerable. Drawing on

expertise in psychodiagnostics, psychological counseling, and corrective-developmental intervention, the educational psychologist is positioned to recognize giftedness in its diverse and frequently atypical presentations and to provide targeted assistance with the personal, emotional, and relational difficulties that such children characteristically experience. The synthesis of psychological expertise with tutoring-oriented approaches yields a qualitatively enriched model of specialist support.

Yet an examination of current professional preparation programs for educational psychologists reveals that this integrated approach remains at the margins of existing curricula. Future educational psychologists typically encounter the topic of giftedness within general courses in developmental or educational psychology, and gain only limited exposure to tutoring within the framework of inclusive education content (Mara, 2023); a systematic program of preparation for integrated tutoring-psychological practice is, however, absent from the overwhelming majority of degree programs. The result is a demonstrable gap in the practical competence of graduates when they are called upon to work with gifted children within a tutoring framework. Bridging this gap through the purposeful integration of relevant competencies into university-level professional education thus constitutes an urgent problem - one that demands both rigorous theoretical grounding and the development of concrete, replicable pedagogical solutions.

Materials and Methods. *Research Design*. A quantitative descriptive approach was adopted as the methodological framework of this investigation, implemented through a cross-sectional survey design. This choice was guided by the core objective of the study: to obtain a reliable snapshot of the current professional preparedness of bachelor ‘s-level psychology students for tutoring-based work with gifted learners, without introducing experimental conditions or monitoring changes across time. Survey methodology was judged particularly well-suited to this purpose, as it allows the systematic collection of self-reported data on knowledge levels, attitudes, and perceived competencies from a defined group of participants within a compact timeframe. The empirical component of the study was carried out over the course of a single academic semester at Abai Myrzakhmetov Kokshetau University, Kazakhstan.

Participants. The study drew its participants from the undergraduate student cohort of the bachelor’s program 6B01101 Pedagogy and Psychology at Abai Myrzakhmetov Kokshetau University. To guarantee that every participant brought a reasonably uniform and professionally relevant background to the survey, a purposive selection procedure was employed rather than random sampling. Three criteria had to be satisfied for a student to be eligible for inclusion: first, active registration in the third year of the 6B01101 Pedagogy and Psychology degree; second, prior successful completion of the professional-cycle modules addressing the psycho-pedagogical basis of work with heterogeneous student groups; and third, documented completion of a field-based teaching practicum within the program. Students at other stages of the degree were not recruited. Those in their first and second years lacked the depth of subject-specific training necessary for a meaningful self-evaluation of the issues examined in the study. Students in their final, fourth year were undergoing graduation procedures and extended off-campus professional internships, circumstances that both constrained their availability and made direct comparison with the target cohort methodologically inappropriate. After applying these criteria, the study group comprised 37 participants, all drawn from the third year of the program. This number was judged adequate to yield findings representative of the defined population.

Data collection instrument. The primary instrument developed for this study was an original questionnaire constructed specifically to address the research questions. It contained four items with closed response sets, where each item offered four answer choices calibrated on a Likert-type rating scale (Tanujaya et al., 2022). The Likert format was preferred over a simple yes/no structure because it captures degrees

of opinion rather than dichotomous positions, thereby generating richer, more differentiated data about participants' self-perceptions.

The four items were each designed to illuminate a separate facet of the problem. Item 1 gauged how well respondents understood the concept of tutoring support conceptually and whether they could identify the concrete techniques and tools used in tutoring practice with gifted students. Item 2 probed the extent to which students recognized the distinctive psycho-pedagogical requirements of gifted children and appreciated why a standard pedagogical approach may be inadequate for this group. Item 3 invited participants to rate, from their own perspective, how thoroughly their current degree program had equipped them to carry out tutoring support activities with gifted learners. Item 4 captured students' stance on whether a dedicated, standalone course on this topic should be incorporated into the educational psychologist preparation curriculum. To establish the content validity of the instrument, each item's wording was mapped against the theoretical constructs underpinning the study, and the resulting draft was submitted to a panel of subject-matter experts in educational psychology and pedagogy for independent review. The expert panel confirmed the adequacy of the items, and no substantive revisions to content were deemed necessary before administration.

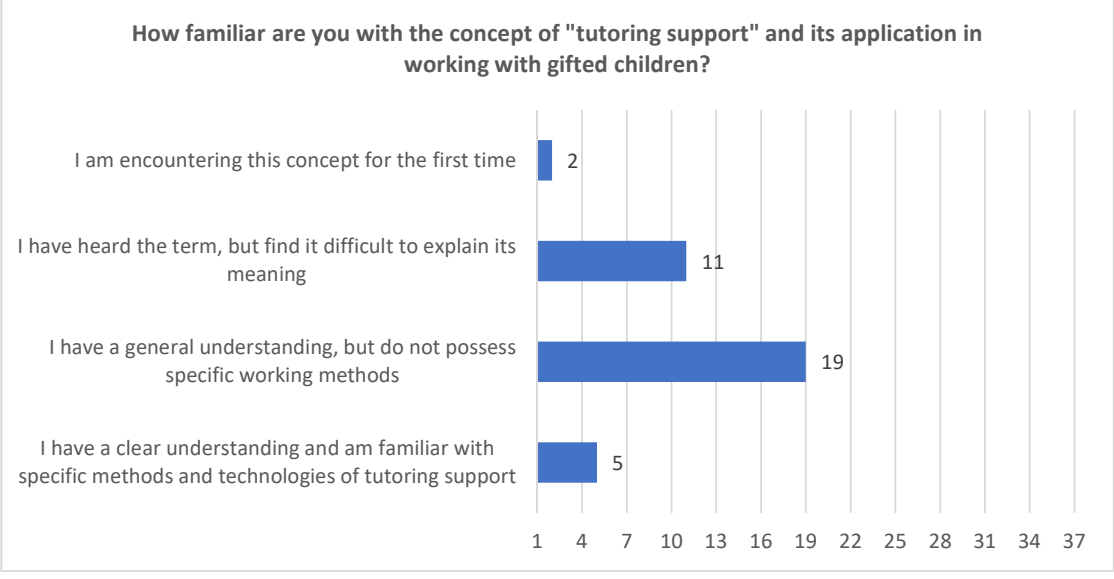
Data collection procedure. The survey was administered in person during regular timetabled teaching sessions at Abai Myrzakhmetov Kokshetau University, using printed questionnaire forms. An in-class, synchronous format was deliberately chosen to ensure uniform conditions for all respondents and to achieve the highest possible completion rate. At the outset of each session, a standardized introduction was delivered to participants, covering the purpose of the study, an explanation of how to interpret and complete the rating scale, and clarification of what would happen with the collected data. Students were made explicitly aware that taking part was a matter of personal choice and that opting out would have no bearing on their academic standing or standing within the program. To protect participant privacy, questionnaires were completed anonymously: no names or identifying codes were recorded on the forms, and at no point in the analytical process were responses traceable to individual students. These procedural safeguards were put in place to reduce the likelihood of socially desirable responding and to encourage frank, unguarded answers. Every student present at the survey sessions submitted a fully completed questionnaire, producing a completion rate of 100% across the sample of 37 participants. No responses required exclusion on grounds of incompleteness or internal inconsistency.

Data analysis. All questionnaire responses were subjected to descriptive statistical analysis. For each item, both the raw count and the corresponding proportion (expressed as a percentage of the total sample) of respondents selecting each answer option were computed. These distributions were then displayed in horizontal bar charts (Figures 1–4) to provide a transparent visual representation of how opinion and self-assessment were spread across the response continuum for every question. The analytical emphasis was placed on two levels: first, identifying the prevailing response pattern within each item; and second, examining the coherence of patterns across all four items - specifically, whether the levels of conceptual knowledge (Item 1), recognition of student needs (Item 2), self-rated readiness (Item 3), and demand for specialized training (Item 4) told a consistent story about the state of professional preparation. All interpretations were grounded in the theoretical framework developed in the introductory section of the article, and the overarching analytical goal was to map out the nature and scope of deficiencies in existing degree programs with respect to equipping graduates for tutoring-oriented work with gifted children. Given the exploratory, descriptive character of the research design and the deliberate (non-random) composition of the sample, no inferential statistical tests were applied to the data.

Results. Based on the study conducted, the following results were obtained (Figures 1–4).

Figure 1

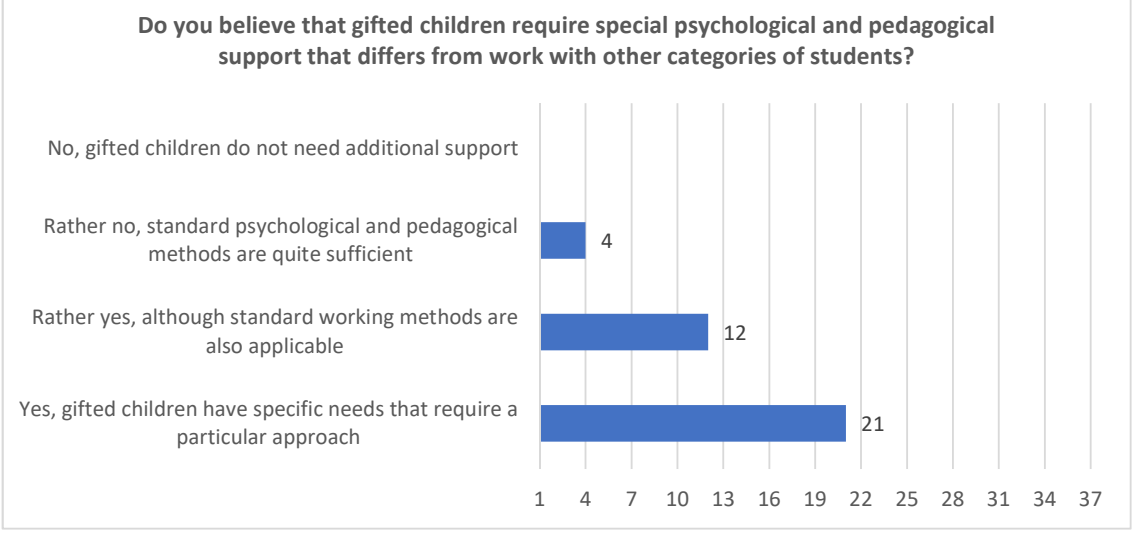
Students' awareness of the concept of tutoring support for gifted children



The first question was aimed at identifying the degree of students' theoretical awareness of tutoring support. Only 5 respondents (13.5%) reported having a clear understanding of the concept under investigation and command of specific methods and technologies of tutoring practice. The largest share of participants, 19 individuals (51.4%), indicated having only a general understanding without command of specific working methods. Eleven students (29.7%) reported having encountered the term but being unable to articulate its meaning, and 2 respondents (5.4%) came across the concept for the first time. Cumulatively, 35.1% of students are either unfamiliar with the concept of tutoring support or acquainted with it only nominally. The findings point to a deficit in theoretical preparation in the area under investigation: the overwhelming majority of prospective educational psychologists do not possess knowledge of tutoring sufficient for its practical application in future professional activity.

Figure 2

Students' perceptions of the need for psychological and pedagogical support for gifted children



The second question was aimed at identifying students' understanding of the needs of gifted children in psycho-pedagogical support. Twenty-one respondents (56.8%) unequivocally confirmed that gifted children have specific needs requiring a specialized approach, while another 21 students leaned toward an affirmative answer while acknowledging the applicability of standard working methods as well. None of the respondents selected a categorically negative answer, and only 4 students (10.8%) expressed doubt regarding the necessity of specialized support. Despite the evident deficit in theoretical knowledge of tutoring recorded in the first question, students nonetheless intuitively recognize the particular vulnerability of gifted children and their need for individualized support. This points to the presence among respondents of a certain degree of professional sensitivity which, however, has yet to be reinforced by concrete instrumental knowledge.

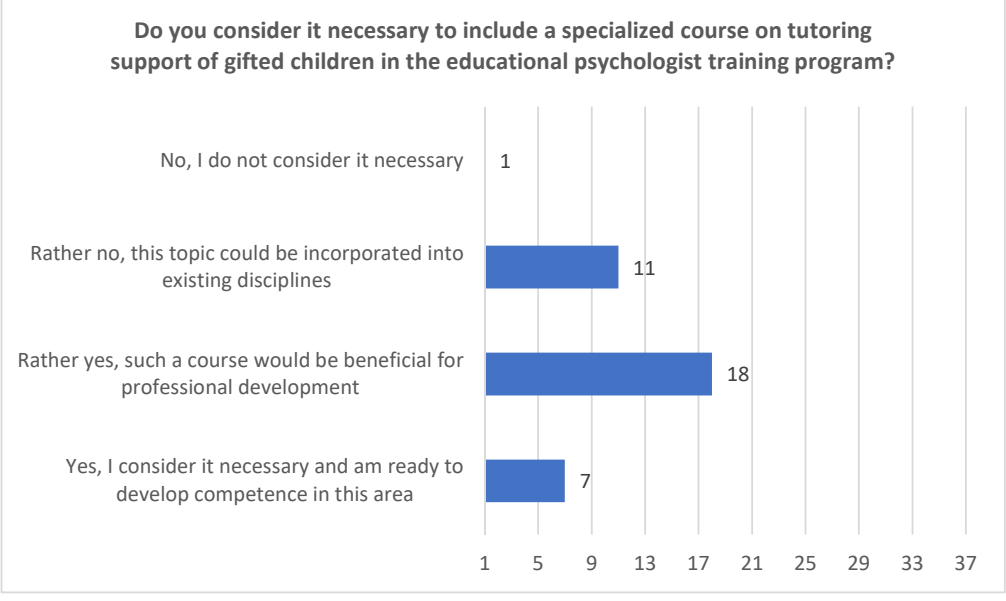
Figure 3

Students' assessment of their readiness for tutoring support of gifted children within the current educational program

The third question made it possible to assess the subjectively perceived level of readiness formed in the course of professional training and presents the most significant picture in the context of the problem under investigation. Only 3 students (8.1%) rated their level of preparation as fully sufficient. Seven respondents (18.9%) indicated a sufficient level of foundational knowledge while noting the need to deepen the practical component. At the same time, the overwhelming majority - 23 individuals (62.2%) - acknowledged that the topic of tutoring support for gifted children is virtually absent from their degree program, and a further 4 students (10.8%) reported a complete absence of the subject under investigation from their working curriculum. Cumulatively, 73% of respondents identify an insufficiency or complete absence of the relevant preparation, which clearly points to the nature of the deficit identified: the degree program does not ensure the formation of educational psychologists' readiness to work with gifted children within the framework of tutoring support.

Figure 4

Students' attitudes toward the need to introduce a specialized course on tutoring support of gifted children



The fourth question recorded students' attitudes toward the necessity of introducing a specialized course and predictably reflects the conclusions arising from the preceding responses. Seven respondents (18.9%) expressed unequivocal support for the inclusion of such a course in the degree program and indicated personal readiness to engage with this area. Eighteen students (48.6%) leaned toward an affirmative answer, acknowledging the professional value of such a course. Eleven individuals (29.7%) adopted a moderately skeptical position, holding that the topic could be integrated into existing disciplines, and only 1 respondent (2.7%) did not consider the introduction of such a course to be necessary. Cumulatively, 67.5% of students support the idea of specialized preparation, reflecting a demand on the part of prospective specialists themselves for the remediation of the identified deficit. Those students who selected the third response option do not deny the necessity of engaging with the subject under investigation but merely propose an alternative organizational format for its incorporation into the degree program.

Overall, the survey results demonstrate that prospective educational psychologists recognize the significance of the problem of supporting gifted children and feel a need for the corresponding professional preparation, yet possess only fragmentary theoretical knowledge of tutoring and do not consider themselves ready to carry out this type of activity - thereby underscoring the necessity of developing specialized content for the preparation of educational psychologists for tutoring support of gifted children within the context of higher professional education.

Discussion. The picture emerging from the empirical data acquires additional depth when situated within the wider international discourse on how educational psychology programs address the theme of giftedness and tutoring-oriented professional practice. Comparing the present findings against a body of foreign scholarship reveals not merely isolated parallels but a consistent cross-national pattern - one that lends the identified problem both breadth and urgency. The low level of students' theoretical command of tutoring support for gifted children uncovered by the first survey item aligns closely with conclusions drawn in research conducted at Croatian teacher education institutions. Grassinger et al. (2010) and Mihić et al. (2019) demonstrated that pre-service teachers consistently scored markedly

lower on both cognitive knowledge and emotional readiness when working with gifted students compared to students with disabilities. The scholars attributed this asymmetry to a structural imbalance embedded in degree program curricula: whereas inclusive education for children with special educational needs occupies at least one compulsory module in most programs, giftedness-related content is confined to elective courses that not all students are required to take. The situation documented in the present study mirrors this pattern with striking fidelity: 73% of respondents evaluated their preparation for tutoring support of gifted children as either largely absent or wholly insufficient, which underscores that the problem transcends any single national educational tradition and reflects a systemic curricular gap reproduced across different countries.

A complementary angle of comparison is offered by the data from the second survey question, where an overwhelming 89.2% of respondents acknowledged the particular psycho-pedagogical needs of gifted children and the necessity of differentiated professional responses. This widespread recognition resonates with observations reported by Shabani et al. (2025) in their study of educational practitioners' orientation toward gifted students in the Kosovo school system. Those researchers noted that educators broadly perceive giftedness as a genuine professional concern and affirm the need for specialized conditions, yet institutional frameworks, legislative gaps, and the absence of practical instruments prevent this awareness from translating into purposeful professional conduct. The same tension surfaces in the present data: students intuitively grasp that gifted children constitute a distinct group requiring individualized support, yet lack both the conceptual vocabulary of tutoring and the practical toolkit to act on that understanding. This contradiction - sensitivity without operational capacity stands as one of the central findings of the study and simultaneously identifies the most productive point of intervention for curriculum designers.

The most substantively proximate parallel to the concerns of the present investigation is found in the work of Zinovyeva et al. (2021), who addressed the preparation of teacher-tutors for giftedness development within higher education contexts. Their analysis affirmed both the feasibility and the necessity of building a teacher's readiness for research-oriented tutoring support as a key mechanism for nurturing gifted children's potential, proposing authentic tutoring practice grounded in a reflective-activity approach as the principal organizational-pedagogical condition for achieving this goal. Against this backdrop, the present study's finding that 67.5% of respondents actively supported the introduction of a specialized course on tutoring support of gifted children takes on particular significance: it signals not merely an externally observed gap but a subjectively felt professional deficit, a demand articulated by the prospective specialists themselves. Critically, the third survey item makes clear that embedding giftedness content incidentally within existing disciplinary courses is insufficient; what is required is a coherently constructed preparatory program that integrates theoretical foundations, practice-based tutoring experience, and structured reflective mechanisms.

Synthesizing the present results with the evidence from comparative international research yields several conclusions of consequence for both theory and professional education practice. To begin with, the insufficient preparation of future educational psychologists for tutoring work with gifted learners is not a localized or context-specific anomaly: it is a transnational phenomenon reproduced - with remarkable consistency across educational systems at different levels of institutional development. Furthermore, an educator's recognition of the importance of the giftedness problem does not, in itself, constitute professional readiness; that readiness requires deliberate, sustained, and systematically structured preparation that goes well beyond general awareness. Finally, equipping an educational psychologist for tutoring support of gifted children demands purpose-built curricular content that weaves together psychodiagnostics competence, tutoring technologies, and reflective

professional practice - content that cannot be delivered adequately within the boundaries of conventional academic disciplines without their thorough reconceptualization. Taken together, these conclusions make a compelling case for designing and piloting a dedicated preparation model for future educational psychologists within the higher professional education system.

Conclusion. Demands for the individualization of learning and the growing acknowledgment - within both the research community and educational policy circles - of the specific psycho-pedagogical profile of gifted students have elevated the question of how to prepare educational psychologists for tutoring-oriented work to the status of a genuinely pressing professional and scientific concern. Despite this shift in discourse, the curricular response within university-level preparation programs has remained largely incommensurate with the scale of the challenge: the topic continues to occupy a marginal or absent position in most degree programs designed for future educational psychologists.

The investigation yielded a coherent and internally consistent picture. Future educational psychologists display a notably developed capacity for professional empathy toward the difficulties encountered by gifted children and intuitively recognize these students as a group requiring individualized, specialist attention. Yet this sensitivity remains unmatched by either a conceptual understanding of tutoring practice or the practical instruments needed to implement it. The roots of this contradiction lie not in individual students' shortcomings but in the architecture of their degree programs, where content relating to tutoring support for gifted learners appears only in fragments if it appears at all. That comparable findings have been documented in studies conducted in Croatia, Kosovo, and Russia confirms that the problem is neither locally generated nor exceptional: it reflects a structural deficit replicated across diverse national educational systems and therefore calls for a response that is equally systematic in character. A point of genuine optimism, however, is that the majority of surveyed students went beyond simply noting the inadequacy of their current preparation: they actively declared a willingness to cultivate tutoring competencies. This motivational readiness constitutes a tangible resource upon which targeted curriculum development can build.

The trajectory of future inquiry emerging from this study points toward the design, theoretical grounding, and empirical testing of a dedicated preparation model for prospective educational psychologists - one specifically oriented toward tutoring support of gifted children within the higher professional education system. Such a model would need to integrate three mutually reinforcing components: practice-saturated disciplinary content, authentic experience of tutoring interaction with gifted learners, and a purposefully constructed reflective framework capable of ensuring that theoretical understanding is progressively consolidated into reliable, transferable professional skills.

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Original Article

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Development of Recurrent Skills of Future Teachers of Preschool Organizations Based on Artificial Intelligence Technologies

Abstract

Introduction. The recurrent nature of the professional activity of a preschool educator in a dynamically changing educational environment necessitates not a one-time acquisition of professional skills, but their sustained, cyclically reproducible application in practical work. *Methodology and Methods*. The empirical basis of the study consisted of a closed-ended survey of 49 third-year students enrolled in the Preschool Education and Upbringing Programme. *Results*. The survey results among third-year students of a pedagogical specialization revealed that the majority of respondents encountered the concept of "recurrent skills" for the first time; however, they acknowledged the need for their purposeful development, critically assessed the existing educational Programme as insufficiently oriented towards their formation, and expressed a preference for teaching practice with reflective components and AI-based simulations over traditional formats such as mentoring and portfolio-based approaches. *Theoretical Significance*. The study introduces the concept of "recurrent skills" as an independent category of pedagogical knowledge, thereby expanding the theoretical understanding of the nature of professional development of a preschool educator. *Practical Significance*. The findings may be applied in the design of educational programs for the training of future preschool educators, oriented towards the cyclically reproducible acquisition of professional skills through the use of reflective practices and artificial intelligence technologies.

Keywords: recurrent skills, future preschool educator, artificial intelligence technologies.

Introduction. The professional activity of a preschool educator (Lillvist et al., 2014) is recurrent in nature, encompassing the organization of daily routines, monitoring children's development, engaging with families, and planning structured activities. Consequently, the traditional teacher training system has been oriented towards the initial formation of these skills. However, the contemporary preschool education system is undergoing a period of profound transformation, driven by the rapid advancement of technology, the revision of professional standards (Ministry of Education of the Republic of Kazakhstan, 2025), and increasingly complex professional demands placed on educators. In a dynamically changing educational environment, the system of preparing future preschool educators faces a new challenge: how to ensure not a one-time acquisition of professional skills, but their sustained, repeatable, and cyclically reproducible application in practical work.

The problem of developing teachers' professional skills has been examined across various scholarly traditions, each of which has made a substantial contribution to understanding the mechanisms of professional formation and its continuous nature. Within the cultural-historical activity theory of Vygotsky and Leontiev (Cong-Lem, 2022), the nature of skill development was fundamentally substantiated: through repeated, purposeful execution of an action, it undergoes gradual automatization and transitions to the level of an operation - that is, the skill ceases to require conscious control and becomes embedded in the structure of activity

as a stable component. This framework allows professional pedagogical skills to be understood not as static formations acquired once during training, but as dynamic structures in a state of continuous development, requiring systematic reinforcement through practical activity.

The concept of the zone of proximal development, originally formulated in the context of child learning, was productively transposed into the context of teachers' professional formation. The work of Warford (2011) demonstrated that pedagogical skills do not simply automatize as experience accumulates, but undergo cyclical de-automatization at each new stage of professional growth: encountering more complex professional tasks, altered working conditions, or updated standards causes previously mastered operations to revert to the status of consciously performed actions, thereby initiating a new cycle of skill development at a qualitatively higher level. Professional development of the educator thus assumes a recurrent, spirally ascending character, rather than representing a linear accumulation of competencies.

The theory of Continuing Professional Development (CPD) systematically reveals the mechanisms by which an educator's professional competencies are regularly updated in a changing educational environment. The research of Sheridan et al. (2009) convincingly demonstrates that the sustained professional development of a preschool educator is ensured not by one-off educational events, but by a structured system of recurring reflective experience that involves cyclical returns to key professional situations with a progressively deepening level of critical engagement. In turn, the research of Merino et al. (2025) emphasizes that in the context of the digital transformation of education, continuing professional development acquires a new dimension: the educator is compelled not only to refine subject-specific and methodological competencies, but simultaneously to acquire technological tools and integrate them into already established professional practices. Questions regarding the preparation of future educators drawing on innovative technologies have been addressed in the research of Cong-Lem (2022) and Shabani et al. (2010), who consider digital and interactive tools as instruments capable of ensuring the repeated, varied reproduction of professional situations within an educational context - thereby bringing the preparation process closer to the genuine recurrent logic of the preschool educator's professional activity.

Despite the substantial body of research in the field of teachers' professional development, the phenomenon of recurrent skills as an independent concept - reflecting the repeatability, renewability, and cyclical nature of the professional competencies of a preschool educator - remains insufficiently studied. A particularly important question concerns the role of artificial intelligence technologies as a tool for developing and sustaining recurrent skills in the process of preparing future educators.

The purpose of this article is to reveal the essence of the concept of "recurrent skills of future preschool educators", to define their structural characteristics, to substantiate the potential of artificial intelligence technologies as a means of developing them, and to assess future educators' readiness to develop the skills under investigation. Recurrent skills of a future preschool educator are professional skills characterized by the repeatability of their reproduction in pedagogical practice, the cyclical nature of their actualization under changing educational conditions, and their renewability at a qualitatively new level of professional development.

The word "recurrent" derives from the Latin "recurrens", meaning "returning, repeating" (Lewis & Short, 1879), and in the scholarly context denotes a process that reproduces itself cyclically, returning to its starting point at a new level. Unlike skills formed on a single occasion and applied in standard situations, recurrent skills represent a dynamic professional structure that is not fixed in a finished form, but is continuously reproduced, updated, and deepened in the course of pedagogical activity. Their essence is revealed through three interrelated characteristics.

The first characteristic is repeatability. The professional activity of a preschool educator is

cyclical by nature and involves the systematic reproduction of the same pedagogical actions: organizing daily routines, conducting developmental activities, observing children, and engaging with parents. According to Leontiev's (1975) activity theory, it is precisely through the repeated execution of an action that it gradually becomes automatized and transitions to the level of an operation, becoming a stable element of the educator's professional repertoire. Repeatability is not mechanical duplication, but the conscious reproduction of a skill that ensures its consolidation and refinement.

Recurrent skills are not merely repeated; they are actualized under new educational conditions (cyclical actualization): with each new group of children, within the framework of an updated professional standard, and in an evolving sociocultural context. Vygotsky (1934) demonstrated that development is not a linear process - it "passes through the same point at each new turn, advancing towards a higher level". Applied to the professional skills of an educator, this means that the same skill - for example, diagnosing a child's development - is reproduced cyclically, yet each time in a new context that demands its reinterpretation and adaptation.

Unlike simple repetition, renewability as the third characteristic implies qualitative enrichment of the skill: each cycle of its reproduction is accompanied by professional reflection, the accumulation of experience, and the attainment of a higher level of pedagogical mastery. This is consistent with the theory of continuous professional development (CPD), according to which the professional skills of an educator are not static; they are continuously renewed in response to the challenges of the professional environment (Sheridan et al., 2009). Warford (2011), in his concept of the zone of proximal teacher development, demonstrated that a skill, having reached the level of automatization, undergoes re-automatization upon encountering new professional tasks, thereby initiating a new cycle of its acquisition at a higher level. Thus, taken together, these three characteristics distinguish recurrent skills from adjacent concepts: unlike "stable skills", they are not fixed in an unchanging form; unlike "skills being formed", they have already been acquired but continue to develop; unlike "general competencies", they are tied to specific, recurrent situations within the professional activity of the preschool educator. Drawing on a systems approach to analyzing the professional competence of an educator, the structure of recurrent skills can be represented as the unity of four interrelated components: cognitive, operational, motivational-axiological, and reflective (Table 1).

Table 1

Structure of recurrent skills

Component	Description
Motivational-axiological component	Determines the orientation and intensity of the reproduction of recurrent skills and encompasses professional motivation, a value-based disposition towards pedagogical activity, and a readiness for continuous professional self-improvement. This component is of particular significance specifically in relation to recurrent skills: without sustained intrinsic motivation, the repeated reproduction of professional actions risks becoming a formal routine, losing its developmental potential. Research into the emotional intelligence of preschool educators demonstrates that professional fulfilment and a sense of joy derived from pedagogical activity are the most critical elements ensuring the stability of professional motivation throughout the entire career of a preschool educator (Xie et al., 2024). The motivational-axiological component serves as the internal driving force behind the renewability of recurrent skills, prompting the educator not merely to reproduce mastered actions, but to strive for their qualitative renewal.
Cognitive component	The theoretical foundation of recurrent skills encompasses professional knowledge of the developmental patterns of preschool-age children, the psychological and ped

	agogical bases for organizing the educational process, and an understanding of the mechanisms underlying one's own professional growth. According to the model of teacher professional competence proposed by Baumert and Kunter (2013), professional knowledge constitutes the system-forming element without which no skill can be reproduced at a qualitatively new level. With respect to recurrent skills, the cognitive component ensures the meaningfulness of each new cycle of skill reproduction: the educator does not merely repeat an action mechanically, but understands its nature, purpose, and potential for adaptation to new conditions. Research in the field of teacher professional expertise confirms that it is precisely cognitive capacities that determine the quality of professional response in recurring situations (Lin et al., 2024).
Operational component	Constitutes the practical core of recurrent skills and encompasses the set of specific pedagogical competencies that are reproduced systematically and purposefully in the professional activity of the preschool educator: the ability to organize a developmental environment, conduct pedagogical observation, build interaction with children and parents, and design and implement educational situations. As demonstrated by the findings of Pinya-Medina et al. (2024), it is precisely the operational competencies of preschool educators that require the most systematic and structured reproduction across varied professional contexts. The operational component directly realizes the characteristic of repeatability inherent in recurrent skills: it is through the repeated practical reproduction of an action that its professional stability is established.
Reflective component	Ensures cyclicality by serving as the mechanism for the comprehension and reinterpretation of each cycle of professional activity. Reflection is defined as a conscious and systematic process of deepening one's understanding of professional experience, integrating cognitive, emotional, and motivational elements (Hommel et al., 2023). This component transforms the simple repetition of a professional action into a genuinely recurrent process: each new cycle of skill reproduction concludes with reflection, which becomes the point of departure for the next, qualitatively superior cycle. Li (2025) demonstrates that the reflective practice of future educators encompasses a cycle of deliberation, planning, action, and evaluation of outcomes which structurally corresponds to the nature of recurrent skills.

All four components of recurrent skills function not in isolation, but within a unified professional-educational cycle: the cognitive component ensures the meaningfulness of reproduction, the operational component ensures its practical realization, the motivational-axiological component provides the internal driving force, and the reflective component ensures qualitative renewal upon the completion of each cycle. The interrelation of these components renders recurrent skills a holistic and dynamic professional formation, rather than a mere sum of repeatable competencies.

Introducing the concept under investigation into scholarly discourse allows for a new perspective on the problem of preparing future preschool educators: the emphasis shifts from the one-time development of a skill to the creation of conditions for its sustained cyclical reproduction and qualitative renewal, including through the use of artificial intelligence technologies. The appeal to artificial intelligence technologies as a tool for developing the recurrent skills of future preschool educators is not coincidental - it is determined by the very nature of this phenomenon. If recurrent skills by their essence require repeated, cyclically organized reproduction across varied professional situations, then traditional forms of preparation - lectures, seminars, and teaching practice - are limited in their capacity to provide the necessary frequency, variability, and individualization of such reproduction.

Artificial intelligence technologies (Ifenthaler et al., 2024) offer the possibility of unlimited repetition of professional situations within a

safe learning environment. AI-based simulators of pedagogical situations, chatbots modelling the behavior of children and parents, and interactive case studies with adaptive feedback create conditions for the repeated reproduction of the same skill across diverse contexts, which constitutes a key condition for developing its recurrent character. The future preschool educator gains the opportunity to "live through" the same pedagogical situation repeatedly, each time varying the conditions and refining their professional response, thereby realizing the first characteristic of recurrent skills, namely, their repeatability.

Equally significant is the fact that artificial intelligence (Crompton & Burke, 2023) possesses a unique capacity for the adaptive escalation of learning tasks in accordance with the level of skill acquisition. AI-based adaptive learning systems track the dynamics of a student's professional development and automatically propose tasks of increasing complexity, thereby realizing the mechanism of skill de-automatization and its transition to a qualitatively new level. AI prevents a skill from becoming "fixed" in an automatized form by continuously generating new professional challenges, thus ensuring the renewability of recurrent skills - their third essential characteristic - in alignment with Warford's (2011) concept of the zone of proximal teacher development, according to which a skill, having reached the level of automatization, undergoes re-de-automatization upon encountering new professional tasks, initiating a new cycle of acquisition at a higher level.

A substantial role in the development of recurrent skills is also played by the continuous and personalized feedback provided by AI technologies. Unlike the episodic feedback characteristic of traditional instruction, AI tools record each professional action performed by the student, analyze it, and deliver immediate, targeted, and substantive feedback that initiates a new cycle of reflection and refinement. It is precisely reflection and feedback that, according to the theory of continuing professional development, constitute the driving forces behind the renewal of an educator's professional skills (Merino et al., 2025), which directly corresponds to the characteristic of cyclical actualization of recurrent skills under changing educational conditions.

Generative artificial intelligence (Yu & Guo, 2023) offers opportunities for designing varied pedagogical scenarios that closely approximate the real conditions of a preschool setting. Future preschool educators can use generative AI tools to independently create and test didactic materials, lesson plans, and interaction scenarios involving children of different ages and developmental levels. Each such cycle of design and testing constitutes a complete iteration of the recurrent development of a skill: from reproduction through reflection to renewal - thereby organically completing the logic of all three characteristics of recurrent skills within a single professional-educational cycle. Thus, artificial intelligence functions not merely as an auxiliary technological tool, but as a system-forming instrument organically embedded in the logic of the recurrent development of professional skills of the future preschool educator. The convergence of the key didactic properties of AI - the infinite reproducibility of professional situations, adaptability to the individual trajectory of skill acquisition, and the continuity of feedback - with the essential characteristics of recurrent skills renders artificial intelligence technologies the most appropriate instrument for their development within the system of professional preparation of future preschool educators.

Materials and Methods. The study involved 49 third-year students enrolled in the degree Programme 6B01201 Preschool Education and Upbringing. The selection of this respondent group was determined by the fact that third-year students already possess sufficient experience of professional preparation, have completed several teaching placements, and are capable of meaningfully evaluating both the content of the educational Programme and their own level of professional readiness. At the same time, they remain in the process of training, which renders the data obtained particularly significant for improving the content of preparation.

A closed-ended questionnaire comprising seven questions, each with four response options (A, B, C, D), was used as the data collection

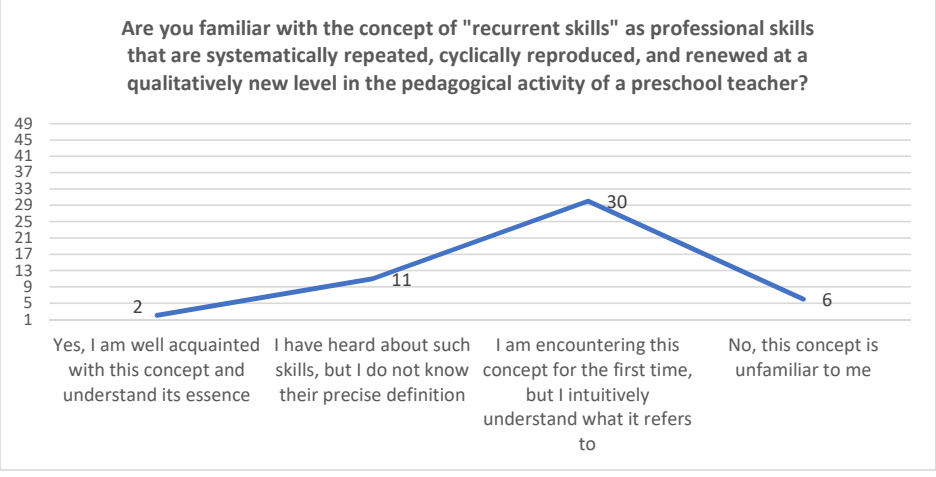
instrument. The first three questions were of a general nature and aimed at identifying the basic professional orientations of the students, while the four core questions were directly focused on the key aspects of the phenomenon under investigation. The present article presents and analyses the results of the four core questions that most fully address the research objectives set. The closed format of the questionnaire ensures the comparability of respondents' answers, minimizes the subjectivity of interpretation, and enables accurate quantitative data processing. Each of the four core questions is directed at diagnosing a distinct aspect of students' readiness: the first identifies the level of awareness of the concept of recurrent skills; the second examines attitudes towards the necessity of their purposeful development in professional preparation; the third assesses the capacity of the educational Programme to create conditions for the recurrent development of skills; and the fourth explores students' preferences regarding the most effective tools and conditions for developing recurrent skills.

The survey was conducted in a group format under classroom conditions. Before completing the questionnaire, students were provided with a brief explanation of the purpose of the study and the essence of the concept of "recurrent skills" to ensure a shared understanding of the key term among all participants. Completion of the questionnaire was carried out anonymously, which contributed to obtaining more objective and candid responses. The average time required to complete the seven questions was 20–25 minutes. The survey was conducted in full compliance with all fundamental ethical principles of research. Before the commencement of the survey, all participants were informed of the purpose and objectives of the study and provided voluntary informed consent to participate. Students were advised of their right to decline participation or to discontinue completing the questionnaire at any point without any consequences for their academic activities. The survey was conducted on the basis of complete anonymity: participants' personal data were neither recorded nor used. The data obtained were employed exclusively for scholarly purposes and processed in aggregated form, precluding the identification of any individual respondent. The confidentiality and security of data at all stages of the study were ensured in accordance with the requirements of research ethics. The data obtained were subjected to quantitative analysis: for each of the four core questions, the absolute number and percentage distribution of responses for each option were calculated. The results are presented in the form of summary charts reflecting the distribution of respondents' answers. The total sample comprised 49 participants, which is sufficient for conducting descriptive statistical analysis within the framework of a pilot study.

Results. The survey results revealed that more than 61% of respondents encountered the concept of "recurrent skills" for the first time yet intuitively understood what it referred to. Approximately 22% of students had heard of such skills but were unaware of their precise definition. Only around 4% of respondents were well acquainted with the concept and understood its essence, while approximately 12% were entirely unfamiliar with it (Figure 1). The low level of terminological awareness is entirely predictable: the concept of "recurrent skills" is not enshrined in either the current professional standard or the educational Programme for the preparation of preschool educators, and therefore the majority of students had not encountered the term in a formal academic context. Nevertheless, it is noteworthy that a significant proportion of respondents, over 61%, intuitively grasp the essence of the phenomenon without knowing its name. This suggests that the phenomenon is genuinely present in their professional experience yet has not been given terminological expression. This observation is consistent with the position of Cong-Lem (2022), according to which professional concepts frequently exist in pedagogical practice long before their scholarly conceptualization. The identified gap between a practical understanding of the phenomenon and its terminological acquisition substantiates the necessity of purposefully introducing the concept of "recurrent skills" into the content of professional preparation of future preschool educators.

Figure 1

Level of awareness of the concept of recurrent skills



The results of the second question (Figure 2) present a heterogeneous yet broadly positive picture. Approximately 39% of students consider the development of recurrent skills to be rather necessary, acknowledging their importance while not regarding them as a priority of professional preparation. Around 31% believe that traditional preparation is sufficient without any special emphasis on recurrence. Approximately 24% lean towards the view that it is enough to form a skill on a single occasion. Only around 6% are firmly convinced of the necessity of purposefully developing recurrent skills. The distribution of responses reflects an orientation typical of students in pedagogical specializations, one that perceives skill development as a completed process within the course of training, without an awareness of the need for its subsequent cyclical renewal. This phenomenon is well described in the theory of continuing professional development: students tend to perceive professional preparation as a linear rather than a cyclical process (Merino et al., 2025). The considerable degree of uncertainty in the responses is also explained by the fact that students do not yet possess sufficient practical experience to fully appreciate the recurrent nature of the professional activity of a preschool educator. In aggregate, more than 45% of respondents nonetheless acknowledge a certain value of recurrent skills, which provides a favorable foundation for incorporating the concept under investigation into the content of professional preparation.

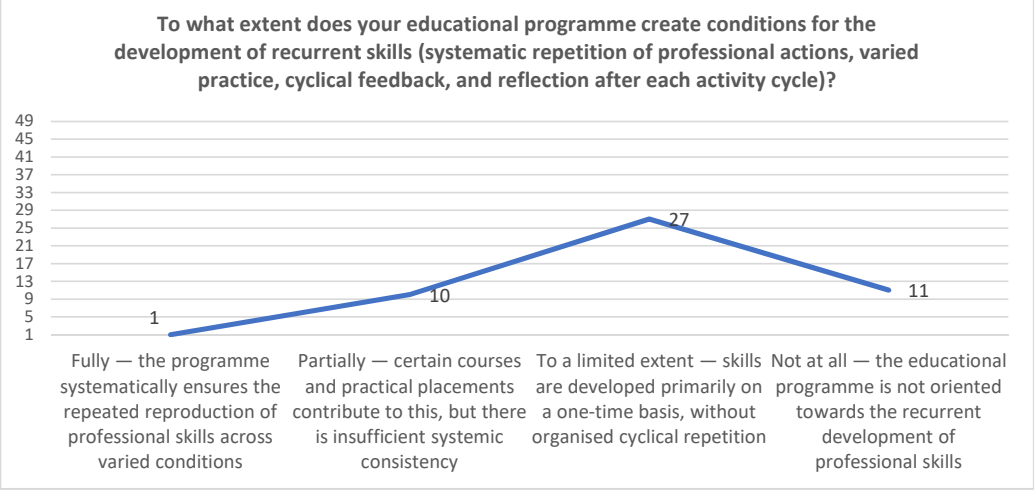
Figure 2

Attitudes towards the necessity of their purposeful development in professional preparation

More than 55% of students assess the capacity of their educational Programme as negligible, indicating that skills are developed primarily on a single occasion without organized cyclical repetition. Approximately 22% believe that the Programme creates no such conditions whatsoever. Around 20% of respondents note a partial correspondence between the Programme and the requirements of recurrent skill development. Only approximately 2% consider that the Programme fully ensures the repeated reproduction of professional skills under varied conditions (Figure 3). The assessment of the educational Programme by the majority of students is entirely predictable and is corroborated by data from international research. Sheridan et al. (2009) indicate that traditional preparation programs for preschool educators generally ensure the initial formation of skills, but do not create systemic conditions for their cyclical reproduction and qualitative renewal. The results of this question reveal a key contradiction: students recognize that their professional skills require repeated reproduction across varied situations, yet the educational Programme does not provide sufficient organizational and pedagogical conditions for this. This contradiction constitutes the principal problem area for improving the professional preparation of preschool educators.

Figure 3

Assessment of the capacity of the educational programme to create conditions for the development of recurrent skills



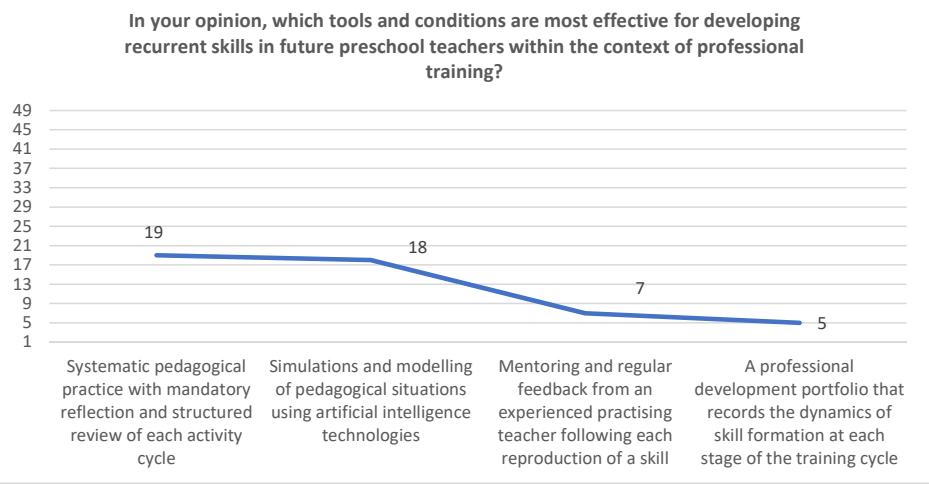
The survey results reveal a consistent hierarchy of student preferences regarding tools that contribute to the development of recurrent skills (Figure 4). The greatest support among respondents (39%) was received by the format of systematic teaching practice with mandatory reflection. In second place, with a narrow margin, came simulations and modelling of pedagogical situations using artificial intelligence technologies, favored by approximately 37% of students. Less support was given to mentoring with regular feedback (approximately 14%) and professional development portfolios (approximately 10% of respondents). The leading position of teaching practice with a reflective component is entirely predictable and theoretically well-founded. Third-year students, having completed several placements, have empirically verified that direct engagement in professional activity constitutes the fundamental condition for developing stable pedagogical skills. This position is consistent with Leontiev's (1975) activity approach, according to which a skill is developed, consolidated, and reproduced primarily through the repeated execution of real practical actions, rather than through their theoretical comprehension in isolation from an activity-based context. The incorporation of mandatory reflection into the structure of practice further

enhances its developmental potential: reflective analysis of one's own experience ensures the conscious consolidation of a skill and creates conditions for its qualitative reproduction at a new level, which corresponds to the spirally recurrent model of the educator's professional development.

A significant finding is the confident second-place position of AI technologies, which surpassed the traditional formats of mentoring and portfolio, demonstrating a high level of technological readiness among future preschool educators and their openness to innovative tools of professional development. The appeal of AI simulations may be attributed to their capacity to reproduce pedagogical situations repeatedly, in varied forms, and under controlled conditions - which is particularly important for the development of recurrent skills: unlike real practice, a simulated environment allows the student to return to the same professional situation multiple times, adjusting their own actions without the risk of negative consequences for the actual educational process. The high level of interest in this tool is consistent with the findings of contemporary research in the field of digital pedagogy, which records a sustained tendency towards the integration of AI technologies into the system of professional preparation of educators (Abdalla et al., 2024).

Figure 4

Tools and conditions for the development of recurrent skills



Students tend to perceive the portfolio as a documenting and reporting instrument, underestimating its reflective and analytical potential. In the scholarly literature, however, the portfolio is regarded as a tool that ensures the systematic recording and critical examination of professional experience over time, which makes it a significant component of recurrent professional development. The modest interest in mentoring, in turn, reflects students' limited personal experience of interaction with a mentor within the context of teaching practice, which reduces the subjectively perceived value of this format. Thus, the results obtained demonstrate that students consciously prioritize tools that provide direct, repeatable, and technologically mediated immersion in professional activity - which corresponds to the recurrent logic of pedagogical skill development.

Discussion. The central contradiction revealed by the present study is as follows: the phenomenon described by the concept of "recurrent skills" is genuinely experienced by future preschool educators in the course of their professional formation, yet it has neither terminological recognition within their preparation system nor a conceptual analogue in the global pedagogical scholarship. The international academic literature does not offer direct analogues for comparison, as recurrent skills as an independent construct are absent from it. Nevertheless, several studies describe adjacent phenomena, and it is precisely the nature of their divergence from our results that

is of greatest analytical interest. Merino et al. (2025), examining the mechanisms of continuing professional development of educators, proceed from the assumption that the repeatability and cyclical nature of professional actions constitute a condition that the educational system must purposefully create. Our results suggest the contrary: students perceive the existing Programme as failing to provide this condition and independently seek tools capable of compensating for its absence. This divergence between institutional declarations and the subjective experience of learners reproduces a pattern identified by Warford (2011): educational programs are designed to support the initial acquisition of skills, but not their de-automatization and re-acquisition under conditions of increasing professional complexity, precisely the mechanism that constitutes the essence of recurrence.

The preference expressed by students for teaching practice with reflection is broadly consistent with international data, yet with an important qualification. Li (2025) and Hommel et al. (2023) regard reflection as a tool embedded within organizationally supported structures of professional development, whereas our students, judging by the results, associate it primarily with individual sense-making of practical experience outside any systematically constructed support framework. The distinction is significant: reflection as a personal habit and reflection as an institutionally organized cycle produce qualitatively different developmental effects, and it is the latter that ensures genuine recurrence of the skill. The high level of interest in AI simulations diverges from prevailing tendencies in international research, where technological tools traditionally occupy an auxiliary position relative to real practice and mentoring (Pinya-Medina et al., 2024). This divergence lends itself to interpretation through the logic of Shabani et al., (2009): a simulated environment makes it possible to manage the level of complexity of a professional task and to reproduce it repeatedly, that is, to artificially create the conditions of the zone of proximal professional development that, in real practice, arise spontaneously and irregularly. Students intuitively select this tool not because they evaluate it as technologically appealing, but because it addresses a specific problem they perceive in their preparation: a deficit of manageable repeatability of professional situations.

The low level of interest in mentoring represents the most pronounced divergence from the international literature. Warford (2011) and Sheridan et al. (2009) regard accompaniment by an experienced practitioner as a condition without which productive progression through the zone of proximal professional development is fundamentally impeded. The fact that our students rank mentoring in second-to-last place reflects not their disagreement with this proposition, but rather the absence of any real experience of high-quality mentoring within existing teaching placements. A tool that a student has not experienced as developmental cannot be selected as preferable, and this in itself constitutes a diagnostic signal for the preparation system. A similar logic accounts for the low interest in portfolios: international researchers identify their reflective potential as significant (Li, 2025; Merino et al., 2025), yet this potential is realized only when specially organized work with the portfolio is in place, whereas in most programs it functions as an instrument of documentation rather than development.

Conclusion. The renewal of the preschool education system, driven by the revision of the professional standard and the growing complexity of demands placed on educators, brings to the fore a problem that has yet to receive a systemic resolution in the theory and practice of professional preparation: how to ensure not a one-time acquisition of professional skills, but their sustained, repeatable reproduction in a dynamically changing educational environment. The absence in pedagogical scholarship of an independent concept describing this phenomenon, despite its evident presence in the real professional activity of the preschool educator, defined the research problem.

With the aim of examining the degree to which future preschool educators are aware of the recurrent nature of professional skills and their

preferences in selecting tools for professional development, a survey of third-year students was conducted. The results demonstrated that the overwhelming majority of respondents intuitively grasp the essence of the phenomenon under investigation without possessing its terminological designation, critically assess the educational Programme as failing to provide conditions for the recurrent reproduction of professional skills, and express a preference for tools of managed repeatability teaching practice with reflection and AI simulations over traditional formats of mentoring and portfolio.

The totality of the data obtained demonstrates that the recurrent skills of the future preschool educator represent not an abstract theoretical category, but a genuinely experienced characteristic of professional formation - one that students themselves identify at the level of practical experience long before its scholarly conceptualization. It is precisely this convergence between the practical experience of students and the theoretical lacuna in international scholarship that substantiates the necessity of introducing the concept of recurrent skills as an independent category of pedagogical knowledge, and of designing on its basis purposeful mechanisms for the professional preparation of future preschool educators.

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Examining the Connection between Teacher Professional Identity and Burnout Levels in Educators

Abstract

Introduction. This study examines the professional identity and burnout levels of English language teachers in Turkistan. *Methodology and methods.* The study was conducted using the Professional Identity Scale and the Maslach Burnout Inventory. A total of 80 teachers from different educational institutions participated in the research. Descriptive statistics showed that teachers generally report moderate burnout and a stable perception of their professional identity across subject-matter, pedagogical, and didactical domains. Reliability analysis indicated strong internal consistency for all subscales. Correlation analysis revealed a meaningful relationship between the two constructs, with the strongest link observed between professional identity and the personal accomplishment component of burnout. *Results.* Emotional exhaustion and depersonalization showed weaker associations with identity dimensions. These findings suggest that teachers' sense of professional effectiveness plays a central role in supporting their well-being and may reduce vulnerability to burnout. *Scientific novelty.* The research shows empirically how scientific dimensions of teacher professional identity are associated with distinct components of burnout and also clarifies which identity profiles function as protective factors or risk factors for burnout. *The practical significance* is that the finding can be used to identify educators earlier and to design targeted interventions to prevent burnout.

Keywords: teacher burnout, professional identity, English language teachers, personal accomplishment, emotional exhaustion, teacher well-being.

Introduction. Teaching is widely recognized as demanding, but the real difficulty goes far beyond knowing the subject well. A teacher works with people every single day, and that means dealing with emotions, expectations, pressure, and sometimes even conflicting responsibilities. Although teachers help shape students' thinking and personal growth, they themselves face heavy workloads and constant emotional tension. Over time, this combination can lead to professional burnout, a condition that gradually drains enthusiasm, lowers job satisfaction, and affects overall performance. Because of this, the connection between a teacher's sense of professional identity and their vulnerability has become an important topic in current educational discussions.

Professional identity essentially reflects how teachers understand their place in the profession: what they believe their responsibilities are, which values guide them, and how they interpret their role within the educational environment. This identity does not appear immediately as they start working; it grows through experience, personal beliefs, collaboration with colleagues, and the atmosphere of the school where they work. Examining how professional identity influences teachers' emotional well-being is crucial for improving both working conditions and the quality of education. To understand

whether having a stable and confident sense of who they are professionally helps them deal with challenges more effectively and maintain interest in their work, or having an unclear, conflicted, or poorly formed identity increases the risk of burnout among EFL teachers.

The problem of professional burnout remains one of the most discussed topics in pedagogy, since it directly affects the quality of teaching and the resistance of teachers to professional difficulties. Burnout was first conceptualized by Maslach and Jackson (1984), where researchers described three key components of burnout: emotional exhaustion, depersonalization, and a decreased sense of personal achievement. These ideas were later developed by Lee and Ashforth (1990) and Brouwers and Tomic (2000), who confirmed that prolonged stress and lack of emotional resources significantly increase the likelihood of teacher burnout. Modern research shows that teacher burnout is associated not only with workload, but also with a whole range of professional factors: a large number of administrative tasks, student behavior, parental expectations, and pressure from educational institutions. Similar trends are observed in different countries. Recent research links increased emotional exhaustion to a lack of autonomy at work, and Akbari and Eghtesadi Roudi (2020) highlight the role of occupational stressors, especially among English language teachers.

Personality characteristics can also increase or decrease the risk of burnout. For example, the study by Fiorilli et al. (2019) and Mojsa-Kaja et al. (2015) suggest that emotional stability and the ability to regulate one's experiences may buffer the effects of occupational stress. At the same time, in the conditions of teaching a foreign language, additional factors are added: language anxiety, the constant need to demonstrate a high level of language proficiency, and uncertain expectations from the administration. Several studies suggest that such conditions can increase the emotional pressure on teachers and increase the risk of burnout. In general, modern data confirm that teacher burnout is a multi-layered phenomenon, depending both on working conditions and on the teacher's internal resources. That is why more and more research is aimed at finding factors that could serve as a protective mechanism. Professional identity is considered a teacher's internal representation of himself in the profession: his values, approaches, responsibilities, and role in the educational environment. Authors working in this area emphasize that identity is formed gradually, changes under the influence of experience and interactions, and reflects how the teacher sees their place in the professional community. Izadinia (2015), Barkhuizen (2016), and Tai & Wei (2020) emphasize that identity is a dynamic structure that integrates personal beliefs and professional expectations.

One of the most common models is the approach of Beijaard et al. (2000), who identified three key components of professional identity: subject, pedagogical, and didactic competence. These dimensions reflect how confident a teacher feels in his knowledge of the subject, in his ability to explain the material, and in choosing methods appropriate for a particular teaching context. The degree of expression of professional identity influences many aspects of teaching activity. Abednia (2012) and Andreasen et al. (2019) noted that a strong identity promotes professional growth, resilience to change, and a deeper understanding of one's role in learning. Chen et al. (2020) link it to job satisfaction and motivation.

Researchers pay special attention to the connection between professional identity and the emotional state of a teacher. Based on Tajfel and Turner's (2004) social identity theory and job demands and resources model, it has been shown that a sense of occupational belonging and role confidence can reduce the impact of job stress. The work of Sun et al. (2022) and Lin et al. (2022) found that professional identity can reduce the risk of burnout by increasing the teacher's internal resources: confidence, resistance to difficulties, and the perception of one's work as meaningful. Work on English language teachers, including studies by Minghui et al. (2018) and Xing (2022), confirms this trend: a strong identity is associated with greater engagement, confidence, and less susceptibility to burnout. Thus, recent research emphasizes

that a teacher's professional identity is not only a personality characteristic, but also an important factor that can mitigate the emotional consequences of stress and increase resistance to burnout (Zhao et al., 2022). Although there is a significant amount of research on teacher burnout and professional identity, data on English language teachers in the regions of Kazakhstan remain limited. In the context of professional pressure, reforms, and growing demands for the quality of teaching, it remains unclear how confident teachers perceive their professional role and how this relates to their emotional stability. There is a lack of empirical evidence to show whether a developed professional identity actually helps teachers cope with burnout. This creates a need for local research that takes into account the characteristics of the educational environment of Turkestan.

The purpose of the study is to analyze the level of professional identity and emotional burnout among English teachers in Turkestan, as well as to identify the nature of the relationship between these two constructs. The study seeks to determine whether individual components of professional identity may serve a protective function and reduce vulnerability to burnout.

Research questions:

1) What is the overall level of professional burnout among English teachers in Turkestan?

2) How do teachers assess their professional identity in terms of subject, pedagogical, and didactic competence?

3) Is there a relationship between overall professional identity and burnout levels?

4) Which components of professional identity are most strongly associated with symptoms of emotional burnout?

Materials and Methods. The study used a quantitative research design, relying on standardized instruments that have been widely applied in international teacher research.

Participants. The participants of this study were English language teachers working exclusively in the city of Turkistan. A total of 80 teachers' survey responses were included in the dataset. The sampling was intentionally focused on the city, as most English language teachers in Turkistan work under similar administrative requirements, teaching loads, and school conditions. This allowed the study to explore burnout and professional identity within a shared educational environment, without the variations typically found between urban and rural schools. Teachers were recruited from public secondary schools, private schools, and universities located within the city. Invitations were distributed through school WhatsApp groups, internet communication channels, and direct messages from English department heads. Participation was voluntary, and each teacher provided informed consent before completing the questionnaire.

The demographic information collected in the first section of the survey included gender, years of teaching experience, and type of institution. The gender distribution reflected the general pattern of English teaching staff in Turkistan: 71 teachers identified as female, while 9 identified as male. This gender imbalance is common in language education in Kazakhstan. Teaching experience among participants varied from early-career teachers to educators with more than two decades of classroom work. This diversity helped capture how burnout and identity may differ across different stages of a teaching career. While most participants worked in public secondary schools, a smaller number taught at universities in Turkistan. An interesting detail is that within the demographic section where participants could optionally share additional professional information, around 40% of teachers noted that they frequently take part in professional development workshops offered by Orleu, IKTU, or local educational organizations.

Instruments. To investigate the relationship between teacher burnout and professional identity, there were used Maslach Burnout Inventory and Beijaard's Professional Identity Questionnaire were used. The first tool used in the research was the Maslach Burnout Inventory Educators Survey (MBI ES), which remains one of the most established instruments for studying burnout in educational settings. It captures how teachers experience the emotional and cognitive demands of their profession by evaluating three central dimensions: emotional exhaustion,

depersonalization, and the sense of personal accomplishment. Responses were provided on a Likert scale ranging from "never" to "every day" in order to evaluate how frequently teachers experience burnout-related symptoms.

The second instrument was a Professional Identity Questionnaire grounded in Beijaard's theoretical framework, which conceptualizes teacher identity across three interrelated areas: subject-matter expertise, pedagogical expertise, and didactical expertise. These dimensions were selected because they correspond closely to how English language teachers in Turkistan typically describe the core areas of their professional role. Teachers responded to all statements using a four-point Likert scale from "strongly agree" to "strongly disagree". When combined with the burnout instrument, the professional identity questionnaire provided a detailed picture of how teachers' understanding of their subject knowledge, teaching abilities, and didactical skills interacts with the emotional demands of their work.

Data collection. Data collection took place over a period of four weeks at the beginning of the fall semester of the 2025-2026 academic year. School principals and heads of English departments in Turkistan were first contacted via email and phone. They were informed about the aims of the study and were asked to share the questionnaire link with English language teachers in their institutions. The survey was administered online using a secure questionnaire platform, such as Google Forms. This format was chosen to make participation easier for teachers with busy schedules and to reach schools located outside the city center. The first page of the online form briefly explained the purpose of the research, assured teachers of anonymity, and included the informed consent statement. Only those who clicked "I agree to participate" could proceed to the questionnaires.

On average, completing all sections took about 15-20 minutes. Participants were able to fill out the survey at any convenient time using a computer or smartphone. To reduce potential response bias, teachers were asked to answer honestly and were reminded that their responses would be used only for research purposes and would not be shared with school administration. In total, 86 responses were received. After screening the data, 6 questionnaires were removed because they were incomplete or contained clearly inconsistent answers; for example, some selected the same option for all items. The final dataset thus included 80 valid cases, which were used in the subsequent analysis.

Data analysis. The collected data were exported to SPSS for statistical analysis. Data were first checked for missing values, outliers, and entry errors. Descriptive statistics (means, standard deviations, frequencies, and percentages) were calculated for all demographic variables, burnout subscales, and professional identity dimensions in order to obtain a general overview of the sample. Before examining the relationship between professional identity and burnout, the assumptions for parametric tests were checked, including normality. Internal consistency of the MBI-ES and the professional identity scale was evaluated using Cronbach's alpha coefficients. To address the main research question, Pearson correlation coefficients were computed between the three burnout components and professional identity dimensions. This allowed us to see whether higher levels of professional identity were associated with lower burnout among English language teachers in Turkistan. Where relevant, independent-samples t-tests and one-way ANOVAs were used to compare burnout and professional identity scores across different groups of teachers. For all analyses, the level of statistical significance was set at $p < 05$.

Results. This section presents the results of the quantitative analysis sequentially. First, basic demographic information about the participants is provided, and then the reliability of the instruments used is assessed. Descriptive measures for professional identity and burnout are then examined to provide insight into the overall level of each construct. In a separate step, the distribution of the data is checked to justify the choice of statistical methods. Next, the relationship between overall measures of professional identity and burnout is analyzed, and finally, the relationships between individual subscales are examined to understand which components are most significant.

Table 1

Demographic characteristics of participants

Variable	Category	Number	Percentage
Gender	Male	9	11.2%
	Female	71	88.8%
Years of experience	0-5 years	57	71.2%
	6-14 years	12	15.0%
	15+ years	11	13.8%
Educational institution	Public school	58	72.5%
	Private school	16	20.0%
	University	6	7.5%

As shown in Table 1, 80 English language teachers participated in the study, with a significant predominance of women. Most of the respondents belong to the group of teachers with up to five years of experience, which reflects the relative youth of the professional staff. In addition, the majority of participants work in public schools, while the share of private schools and universities is noticeably smaller. Such proportions help to better understand the professional environment within which levels of identity and burnout are formed. These data give an idea of how homogeneous the sample is and which groups of teachers are most actively represented.

Table 2

Reliability statistics for the study instruments

Instrument/Subscale	Number of items	Cronbach, α
Professional Identity (total)	18	.881
Subject matter expertise	6	.751
Pedagogical expertise	6	.718
Didactical expertise	6	.713
Maslach Burnout Inventory	22	.862
Emotional exhaustion	9	.855
Depersonalization	5	.799
Personal accomplishment	8	.896

Table 2 illustrates that both instruments used demonstrated high internal consistency. The overall indicator of professional identity has a high alpha value, and all three of its subscales also show strong reliability, which indicates the stability of responses in each area. The burnout scale was no less reliable: the overall alpha coefficient was high, and individual components, emotional exhaustion, depersonalization, and personal achievement, also showed good indicators. These results confirm that the instruments correctly measure the stated construct domains, and the resulting data can be used for further analysis without questioning their robustness.

Table 3

Descriptive statistics for professional identity

Statistic	Total	SME	PE	DE
Mean	2.7785	2.7375	2.7771	2.8208

SD	0.53349	0.64128	0.59294	0.57416
Min	1.44	1.33	1.17	1.50
Max	3.72	3.83	4.00	3.83

Given Table 3 shows the overall professional identity score had a mean of 2.78, indicating teachers' consistently positive perceptions of their professional role. The three subcomponents, subject, pedagogical, and didactic competencies, have very similar average values, ranging from 2.73 to 2.82. The scatter of data across subscales is moderate, as can be seen from the standard deviation values, which range from 0.57 to 0.64. The minimum and maximum indicators also demonstrate that among the participants, there are no sharp deviations in any direction: the majority of respondents assess their professional qualities at approximately the same level. This uniformity confirms that teachers perceive their competence quite holistically, without strong biases towards one of the areas.

Table 4

Descriptive statistics for teacher burnout

Statistic	Total	EE	D	PA
Mean	2.3710	2.1889	1.4950	3.1234
SD	0.89706	1.16486	1.16878	1.48296
Min	0.41	0.00	0.00	0.25
Max	6.00	6.00	6.00	6.00

An analysis of burnout indicators, as shown in Table 4, indicates that the majority of teachers have a burnout level in the low-medium range. The average value was 2.37 with a fairly moderate spread of data (SD = 0.90). The minimum score was close to zero, which means that some teachers show virtually no symptoms of burnout. However, the maximum value is 6.00, which indicates that there is a small group of teachers experiencing significant signs of emotional exhaustion and other aspects of burnout. In general, it can be assumed that moderate levels of burnout prevail among respondents, without pronounced extremes.

Table 5

Correlation between professional identity and burnout

Variable	Professional identity	Burnout
Professional identity	1	.510**
Burnout	.510**	1

As illustrated in Table 5, correlation analysis showed a fairly clear relationship between general indicators of professional identity and burnout. The correlation coefficient was $r = .510$ with a significance level of $p < .001$. This means the presence of a stable relationship of medium strength: the higher the overall level of burnout, the weaker the teacher feels his professional identity, and vice versa. The connection is not overly strong but sufficiently pronounced to indicate a real mutual dependence of these two phenomena in the sample of teachers.

Table 6

Correlations between subscales

Burnout Subscales \ PI subscales	SME	PE	DE
EE	.079 (p=.113)	.139 (p=.218)	.222* (p=.048)
D	-.141 (p=.213)	-.168 (p=.136)	-.124 (p=.273)
PA	.703 (p=.000)	.640 (p=.000)	.645 (p=.000)

Table 6, on comparison of subscales revealed a more complex picture. Weak associations showed emotional exhaustion and depersonalization in most cases; the coefficients were low and statistically insignificant. The exception was the weak but significant relationship between emotional exhaustion and the didactic component of identity ($r = .222$, $p < .05$). A completely different situation was observed with personal achievements. This subscale demonstrated the highest and most consistent coefficients, ranging from .640 to .703, with respect to all three components of professional identity. In fact, it was the feeling of professional success that turned out to be the indicator that is most closely related to how the teacher perceives his professional self. This suggests that self-awareness and confidence in one's accomplishments serve as a protective factor that moderates other aspects of burnout. The findings indicate that teachers generally maintain a strong professional identity and exhibit moderate levels of burnout. There is a tangible connection between the two constructs: the more the teacher's emotional state is disturbed, the less professionally confident he feels. The personal achievement component turned out to be a particularly important element; it was this element that showed the most pronounced relationships with the three dimensions of professional identity. This allows us to consider a sense of professional success as a key indicator influencing the well-being of a teacher.

Discussion. The results of the study provide an opportunity to take a new look at the professional well-being of English teachers in Turkestan. Despite the common stereotype that teaching is inevitably accompanied by emotional burnout, the findings show that the majority of participants demonstrate only moderate levels of burnout. The average values on the scales of emotional exhaustion and depersonalization turned out to be relatively low, while the indicator of personal achievements, on the contrary, was noticeably higher. This may indicate that many teachers, even when faced with professional challenges, retain a sense of personal efficacy. Similar findings were reported by Sokal et al., (2020) and Russell et al. (2020), who found that many teachers maintained professional resilience despite stressful working conditions. Comparable results were also identified by Sánchez-Pujalte et al. (2021), who emphasized that teachers were able to preserve emotional commitment and professional motivation even during periods of educational uncertainty. In a city where education is actively developing, teachers probably feel the demand for their work and see the practical result of interaction with students.

The respondents' professional identity also showed fairly consistent results. Regardless of their length of service and place of work, teachers assessed their subject, pedagogical, and didactic competencies approximately equally. This uniform profile may be explained by the fact that in Kazakhstan the system of advanced training is quite standardized; many teachers undergo similar courses and trainings, which form a unified professional field. Another possible factor is the relatively young sample: the predominance of teachers with up to five years of experience may influence a more optimistic self-assessment of competence, since it is during this period that teachers usually maintain a high level of involvement and try to actively develop. Similar observations were also

made by Rojas et al. (2025), who emphasized that professional identity is closely connected with teachers' adaptation and engagement in different educational contexts. Likewise, van der Want et al. (2019) argued that strong interpersonal role identity positively influences teachers' engagement and professional self-efficacy.

The most interesting results emerged when analyzing the relationship between professional identity and burnout. The general correlation between the two constructs turned out to be quite noticeable: the higher the burnout level, the weaker the feeling of professional confidence. This finding is consistent with numerous recent studies that emphasize that burnout over time undermines a teacher's self-image as a competent professional (Li et al., 2023; Lin et al., 2022; Sun et al., 2022). However, in our sample, this connection manifested itself through rather unexpected accents. It turned out that the main "bridge" between the two constructs is personal achievements. It is this burnout subscale that is most closely related to all dimensions of professional identity. Teachers who feel that they are coping with their tasks show a high level of professional self-esteem, and conversely, the loss of a sense of effectiveness is almost immediately reflected in the perception of their own professional role. This supports the findings of Kim and Lee (2021), who argued that teacher efficacy plays a mediating role between identity and burnout. Likewise, Ratnaningtyas et al. (2025) found that resilience and professional identity are strongly associated with lower burnout levels among educators. Similar conclusions were presented by Lin et al. (2022), who demonstrated that professional identity acts as a protective psychological factor against burnout among teachers during challenging educational conditions.

Emotional exhaustion, on the contrary, turned out to be associated only with the didactic component, and even then quite weakly. This may mean that fatigue most often affects the technical and organizational aspects of work, such as lesson planning, preparing materials, and monitoring progress, but does not always affect a deeper sense of professional identity. Teachers can be tired, but remain confident in their own knowledge and teaching approaches. Similar patterns were identified by Sánchez-Pujalte et al. (2021), who reported that emotional exhaustion does not necessarily destroy teachers' professional competence or emotional commitment to teaching. As for depersonalization, its absence of significant connections with any components of professional identity suggests that this aspect of burnout is weakly expressed in the sample. This finding partially differs from the results of Li et al., (2023), who observed stronger associations between burnout dimensions and professional identity among Chinese teachers. Such differences may be explained by institutional conditions, workload differences, or cultural and educational contexts. Many teachers are likely to feel tired, but not to the point of becoming emotionally detached from their students.

Overall, the results show that a teacher's professional identity suffers most not from fatigue as such, but from a sense of personal ineffectiveness. This observation is scientifically valuable because it demonstrates that psychological perceptions of competence may influence burnout more strongly than emotional tiredness itself. Similar arguments were proposed by Lin et al. (2022), Li et al. (2023), and Sun et al. (2022), who emphasized that professional identity functions as a psychological resource protecting teachers from burnout. Furthermore, Zeng et al. (2020) highlighted the importance of organizational support and psychological factors in maintaining professional well-being. Comparable findings were also discussed by Altinay and Bicentürk (2023), who emphasized that supportive educational environments reduce burnout and strengthen teachers' professional sustainability. In addition, Russell et al. (2020) noted that institutional support and engagement significantly decrease teachers' emotional exhaustion and turnover intentions. Thus, the results highlight the need to create an environment in which teachers not only gain new knowledge but also see tangible evidence of their effectiveness. This could be a mentoring system, regular professional feedback, or participation in small, successful

projects where the teacher can observe concrete improvements in student learning. In this regard, the findings of Rojas et al. (2025) also support the importance of institutional support and professional recognition in preventing teacher burnout. Similarly, Altinay and Bicentürk (2023) stressed that sustainable professional environments strengthen teachers' resilience and organizational commitment. In the context of Turkestan, where education is actively developing, enhancing the sense of professional achievement may be a key factor in preventing burnout among teachers.

Conclusion. The conducted research allowed us to see a more vivid and realistic picture of how English teachers in Turkestan experience their professional role and what manifestations of emotional burnout are really familiar to them. The results show that the majority of teachers maintain confidence in their own competence, despite the workload and external challenges. Their professional identity remains quite stable, and the level of burnout is moderate, which indicates internal resources and the ability to adapt to difficulties.

The connection between professional identity and a sense of personal achievement stands out in particular. It was this component that turned out to be key in understanding what helps a teacher "stay afloat". When a teacher sees that his work is bringing results, this becomes a kind of protection against burnout. On the contrary, a lack of a sense of effectiveness significantly weakens self-confidence and makes teachers more susceptible to emotional exhaustion. This finding emphasizes that teacher support should be built not only around demands and accountability, but also around creating situations where teachers can observe their own progress.

Another important point is the differences between burnout components. Emotional fatigue and depersonalization manifest themselves differently among teachers and do not always affect their professional perception. This shows that reducing workload is only one part of the solution, while enhancing a sense of professional success can be an equally important preventive tool. Thus, the results of the study emphasize the importance of working with professional identity as a living, developing element of teaching activity. An environment in which teachers feel valued, validated, and have the opportunity to develop is a key factor in preventing burnout and maintaining the quality of their work.

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The Impact of Artificial Intelligence on Cognitive Skills Development in Future Teachers

Abstract

Introduction. The study investigates the impact of Artificial Intelligence (AI), particularly ChatGPT, on the development of cognitive skills in future specialists. It explores how AI integration into higher education can enhance critical thinking, problem-solving abilities, and personalized learning while addressing ethical concerns such as academic integrity, technological dependence, and data privacy. *Methodology and Methods*. A mixed-methods approach was applied, combining qualitative and quantitative techniques. Data were collected from 148 third- and fourth-year students of the "Teaching and Primary Education Methodology" program through surveys, questionnaires, and semi-structured interviews. Statistical analyses, including t-tests and ANOVA, were employed to examine the effects of ChatGPT on students' cognitive activity, learning engagement, and perception of AI in education. *Results*. Findings indicate that ChatGPT significantly enhances students' analytical and problem-solving skills, promotes deeper comprehension of content, and increases engagement and motivation. A majority of students reported that AI enables personalized learning pathways, while a minority emphasized its role in monitoring academic progress. Identified challenges include ethical considerations, limited technical support, and data privacy concerns. Nevertheless, AI tools were generally perceived as beneficial for cognitive skill development and active learning. *Scientific novelty*. The study demonstrates that AI, when ethically integrated, fosters cognitive growth and critical thinking in future specialists. *Practical significance*. The results provide evidence-based recommendations for using AI in education, emphasizing responsible implementation to enhance learning quality, motivation, and individualized educational trajectories.

Keywords: AI, ChatGPT, cognition, university, personalization, engagement.

Introduction. The integration of artificial intelligence (AI) technologies, particularly ChatGPT, into education has introduced new opportunities for personalized learning, student engagement, and cognitive development. AI enables adaptive learning pathways that enhance analytical thinking, critical skills, and overall learning efficiency. It also supports the generation of educational materials, contributing to deeper understanding and improved knowledge acquisition (Seo et al., 2021; Bollaert, 2025; Deroncele-Acosta et al., 2025). Studies emphasize that excessive dependence on AI tools such as ChatGPT may negatively affect independent learning and objectivity in academic assessment (Phua et al., 2025). Therefore, AI should complement rather than replace traditional teaching methods (Roe & Perkins, 2022; Sullivan et al., 2023; Paskova, 2023).

Methodologically, this study applies both qualitative and quantitative approaches. Data were collected through student surveys, and statistical analysis (t-tests and ANOVA) was

used to evaluate the impact of ChatGPT on academic performance. Respondents were divided into four groups based on language and educational background, and data were gathered using a 5-point Likert scale questionnaire. AI technologies, particularly generative systems like ChatGPT, have significantly transformed education by enabling real-time personalized feedback, adaptive learning, and improved problem-solving skills (Albadarin et al., 2024; Tsiatsos et al., 2021; Rane et al., 2023). These systems support individualized learning paths aligned with Education 4.0 and 5.0 models. Research shows that AI enhances critical thinking and cognitive engagement by providing immediate feedback and interactive learning support (Kukulska-Hulme & Shield, 2020; Haleem et al., 2022; Nasr et al., 2025; Deep & Chen, 2025). However, its effectiveness depends on the quality of interaction, particularly in higher-order thinking processes.

ChatGPT is widely used in education for generating content, answering questions, and supporting online learning environments. However, privacy risks remain a key concern, as large language models may expose sensitive data (Shahriar & Dara, 2025). Additionally, the quality of AI-generated feedback depends on prompt design (Jacobsen & Weber, 2025). Studies also show that ChatGPT positively influences student engagement and learning performance by providing instant feedback and supporting problem-solving skills (Kasneci et al., 2023; Pradana et al., 2023). In specialized fields such as computer science, AI integration has demonstrated improved academic outcomes (López-Fernández & Vergaz, 2024). Despite these benefits, AI cannot replace educators. It should be used as a supportive tool under proper regulatory and pedagogical frameworks (Fitria, 2021; Dwivedi, 2023). Effective integration requires balancing innovation with ethical responsibility, ensuring data privacy, fairness, and academic integrity (Akgun & Greenhow, 2021; Zhai et al., 2020; Zhai, 2023; Rachovski et al., 2024).

Recent studies highlight the growing role of artificial intelligence (AI) in education, particularly in enhancing learning processes, cognitive development, and student engagement. Akgun and Greenhow (2021) emphasize ethical concerns, noting that excessive reliance on AI may weaken students' critical thinking and independent judgment. Similarly, Dwivedi et al. (2023) and Albadarin et al. (2024) stress that although AI offers significant educational benefits, it also raises issues related to academic integrity, algorithmic bias, and learner autonomy. In contrast, Haleem et al. (2022) and Kasneci et al. (2023) argue that AI tools such as ChatGPT can positively influence cognitive skills, improve academic performance, and support personalized learning when used appropriately. However, the effectiveness of AI depends on responsible integration and clear ethical guidelines, particularly regarding data use and content reliability (Zhou et al., 2024). Methodological trends in this field increasingly employ mixed methods approaches. Japoshvili-Ghvinashvili and Suleman (2023) demonstrate that combining quantitative and qualitative methods provides a more complete understanding of AI's impact on education by capturing both measurable outcomes and user experiences.

Based on this framework, the present study investigates the influence of AI technologies, particularly ChatGPT, on cognitive skills development among future specialists. The study focuses on 148 third- and fourth-year students (aged 22–23) from the "Teaching and Primary Education Methodology" program at the Kazakh National Women's Pedagogical University. The sample was divided according to language of instruction (Kazakh and Russian) to explore potential differences in perceptions within a multilingual educational context. Data were collected using questionnaires and semi-structured interviews. Quantitative data were analyzed using descriptive statistics, t-tests, and ANOVA, while qualitative data were examined through thematic and sentiment analysis. Structural equation modeling (SEM) was additionally considered to explore relationships between AI usage, engagement, and learning outcomes. Ethical standards were strictly observed, ensuring

informed consent, voluntary participation, and complete anonymity of respondents. Overall, this study aims to provide a concise but comprehensive understanding of how AI, particularly ChatGPT, influences cognitive development, academic engagement, and learning experiences in higher education.

Purpose of the study. The purpose of this study is to examine the impact of artificial intelligence (ChatGPT) technologies on the development of cognitive skills among future specialists in higher education, as well as to identify their effectiveness in the learning process and their influence on students' academic engagement and individualized learning pathways.

Materials and Methods. This study adopted a mixed-methods research design to investigate the impact of Artificial Intelligence (AI), particularly ChatGPT, on the development of cognitive skills among future specialists. The integration of quantitative and qualitative approaches allowed for a comprehensive analysis of both measurable patterns and in-depth perceptions of students regarding AI-supported learning. The quantitative component focused on examining statistical relationships between AI usage and academic indicators, while the qualitative component aimed to explore students' experiences, attitudes, and interpretations of AI in the educational process.

Participants. The participants of the study were 148 undergraduate students enrolled in the "Teaching and Primary Education Methodology" program at the Kazakh National Women's Pedagogical University in Almaty. All respondents were third and fourth-year students aged 22–23 years. The sample was purposefully selected due to the participants' sufficient academic background and prior experience with digital learning tools, which enabled them to critically evaluate the educational use of AI technologies. To explore potential differences in perception, the participants were divided into four groups based on the language of instruction (Kazakh and Russian), considering the multilingual and multicultural context of the educational environment in Kazakhstan.

Data collection instruments. Data were collected using multiple instruments to ensure methodological triangulation. A structured questionnaire based on a 5-point Likert scale was employed to measure students' perceptions of AI effectiveness, academic engagement, cognitive skill development, and learning motivation. The questionnaire included both closed-ended and open-ended questions, allowing the collection of both quantitative and qualitative data. In addition, semi-structured interviews were conducted with selected participants to obtain more detailed insights into their experiences with ChatGPT and other AI tools in educational settings. Supplementary qualitative observations were also considered to better understand the practical use of AI in academic activities.

Procedure. The data collection procedure was conducted in several stages. First, participants were informed about the purpose of the study and assured of confidentiality, anonymity, and voluntary participation. Second, questionnaires were administered both electronically and in paper format, depending on accessibility. Third, semi-structured interviews were conducted to deepen the understanding of emerging themes identified in the survey data. All collected data were anonymized before analysis in accordance with ethical research standards.

Data analysis technique. Data analysis was performed using both quantitative and qualitative techniques. Quantitative data were analyzed through descriptive statistics (frequency distributions and percentages) and inferential statistical methods, including independent-samples t-tests and one-way analysis of variance (ANOVA), to determine statistically significant differences between groups. A significance level of $p < 0.05$ was applied. Qualitative data obtained from open-ended survey responses and interviews were analyzed using thematic content analysis, focusing on key themes such as cognitive skill development, academic engagement, ethical considerations, and learner autonomy.

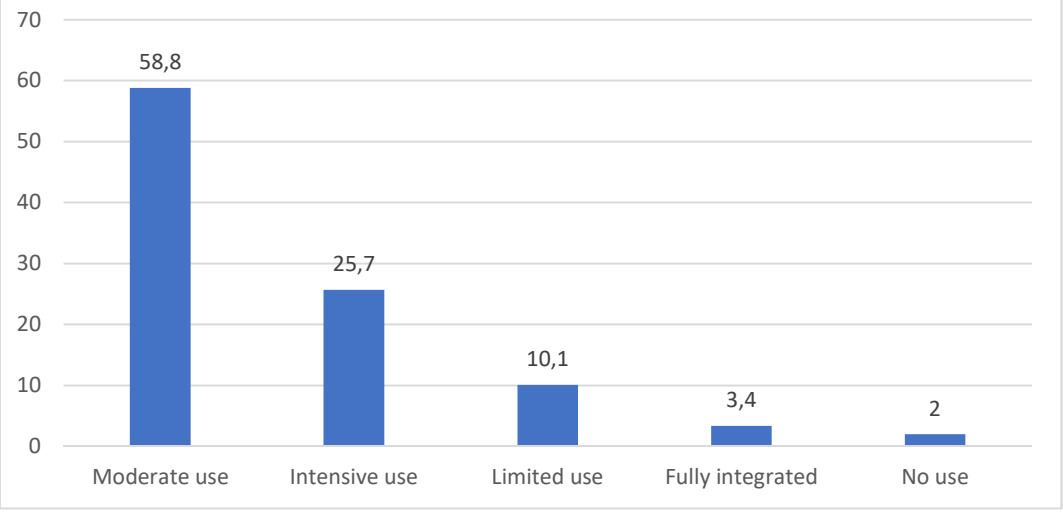
Ethical considerations were strictly observed throughout the study. Participation was voluntary, informed consent was obtained from

all respondents, and confidentiality was fully ensured. No personally identifiable information was used in the analysis or reporting of results. The study adhered to established ethical principles in educational research, including data protection and responsible handling of participant information. Overall, the methodological framework of this study integrates quantitative measurement with qualitative interpretation, enabling a robust evaluation of the role of ChatGPT and other AI tools in enhancing cognitive skills, academic engagement, and learning outcomes in higher education.

Results. The study involved 148 fourth-year students enrolled in the "Teaching and Primary Education Methodology" program at Kazakh National Women's Teacher Training University. The purpose of the research was to examine students' perceptions of artificial intelligence (AI) technologies and their implementation in inclusive educational practices. Data were collected using a five-point Likert scale questionnaire that assessed students' attitudes toward AI integration, its effectiveness, cognitive benefits, implementation barriers, and recommendations for future use.

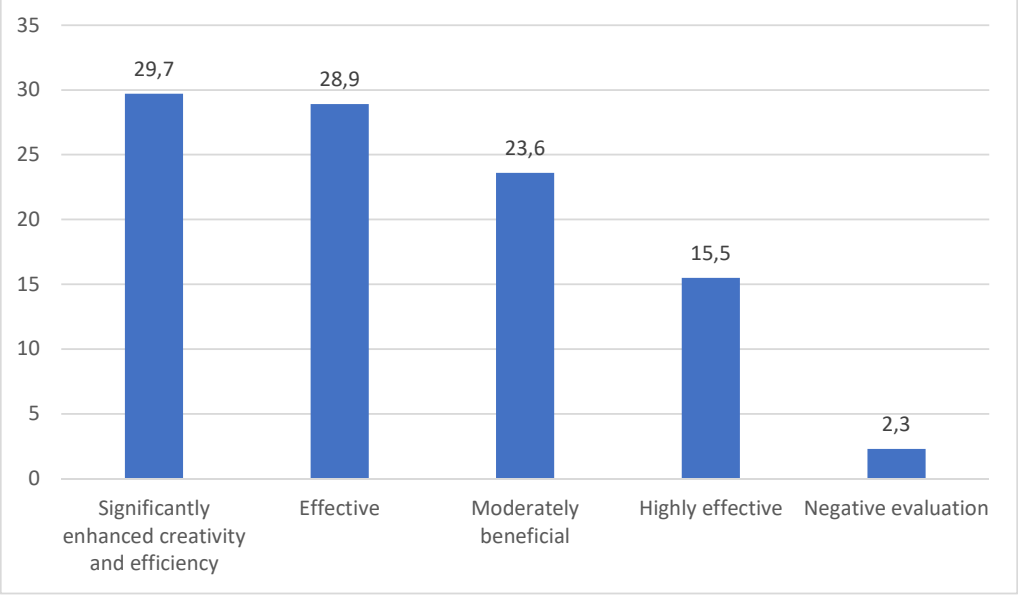
Figure 1

Evaluation of AI usage in the educational process



The findings presented in Figure 1 indicate that AI technologies have become increasingly integrated into the educational process. The majority of participants (58.8%) reported moderate use of AI tools in their academic activities. Furthermore, 25.7% indicated intensive use of AI technologies, demonstrating that a substantial proportion of students actively employ AI to support their learning. A smaller percentage of respondents reported limited use (10.1%), while only 3.4% stated that AI was fully integrated into their educational activities. The proportion of students who did not use AI at all was relatively low (2.0%). These findings suggest that AI technologies are gradually becoming an important component of students' educational experiences.

Figure 2
Effectiveness of using ChatGPT in the educational process



The results presented in Figure 2 demonstrate generally positive perceptions regarding the effectiveness of ChatGPT in the educational process. Approximately 29.7% of participants reported that ChatGPT significantly enhanced both creativity and learning efficiency. Additionally, 28.9% evaluated the tool as effective, while 23.6% considered it moderately beneficial. A further 15.5% perceived ChatGPT as highly effective in supporting academic learning. Only 2.3% of respondents expressed negative evaluations. Overall, the findings indicate that students view ChatGPT as a valuable educational resource that contributes positively to learning outcomes.

Figure 3
Opportunities of AI for improving students' cognitive skills

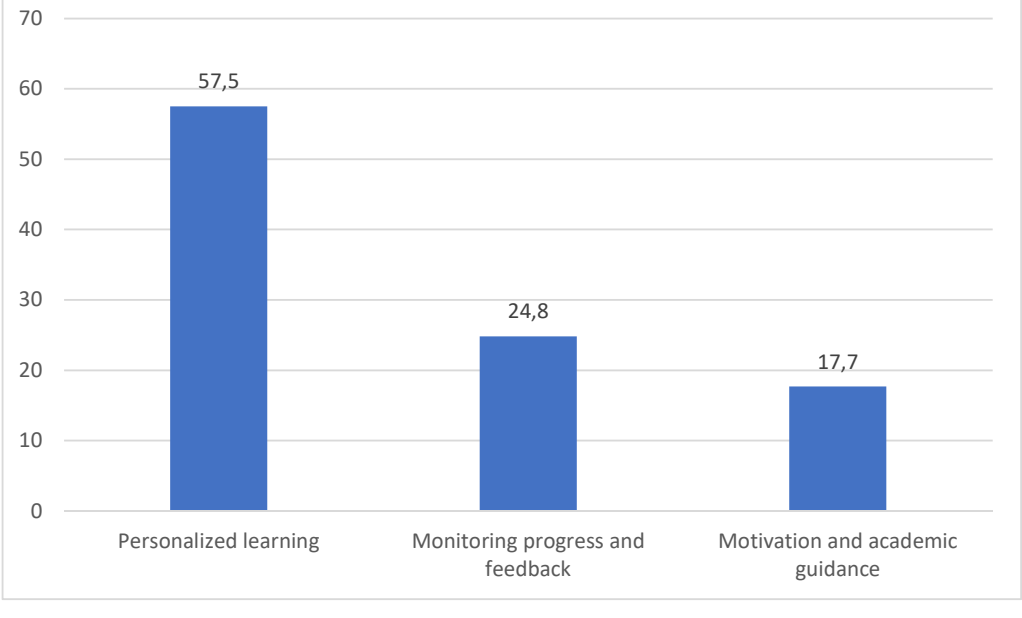
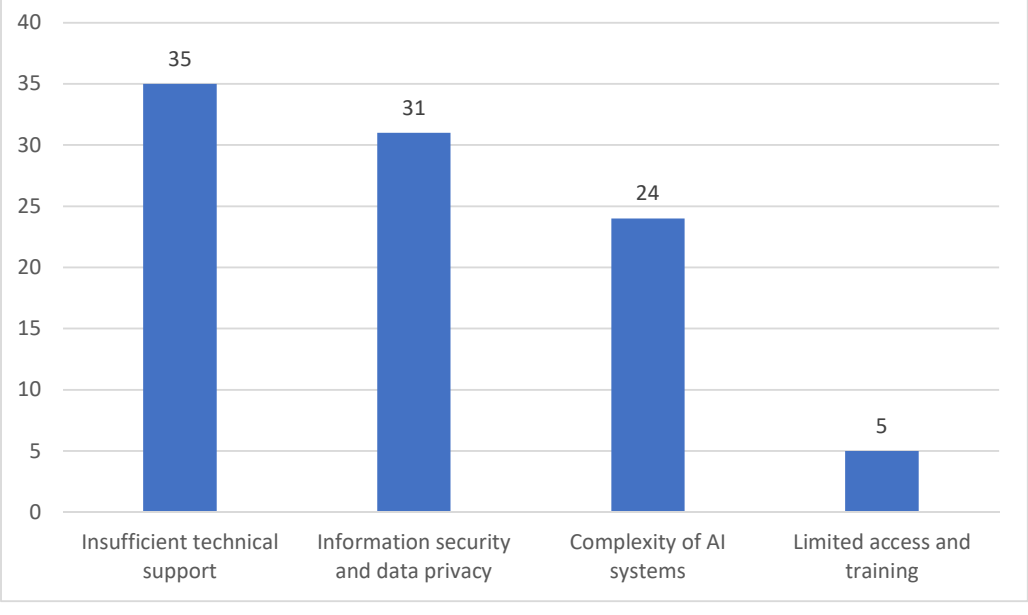


Figure 3 illustrates students' perceptions of AI technologies in supporting cognitive skill development. More than half of the respondents (57.5%) identified personalized learning opportunities as the most significant advantage of AI applications. Approximately 24.8% emphasized AI's ability to monitor learning progress and provide timely feedback. Another 17.7% highlighted the psychological support that AI systems can provide through motivation and academic guidance. These findings suggest that students perceive AI as an effective tool for enhancing both cognitive development and individualized learning experiences.

Figure 4

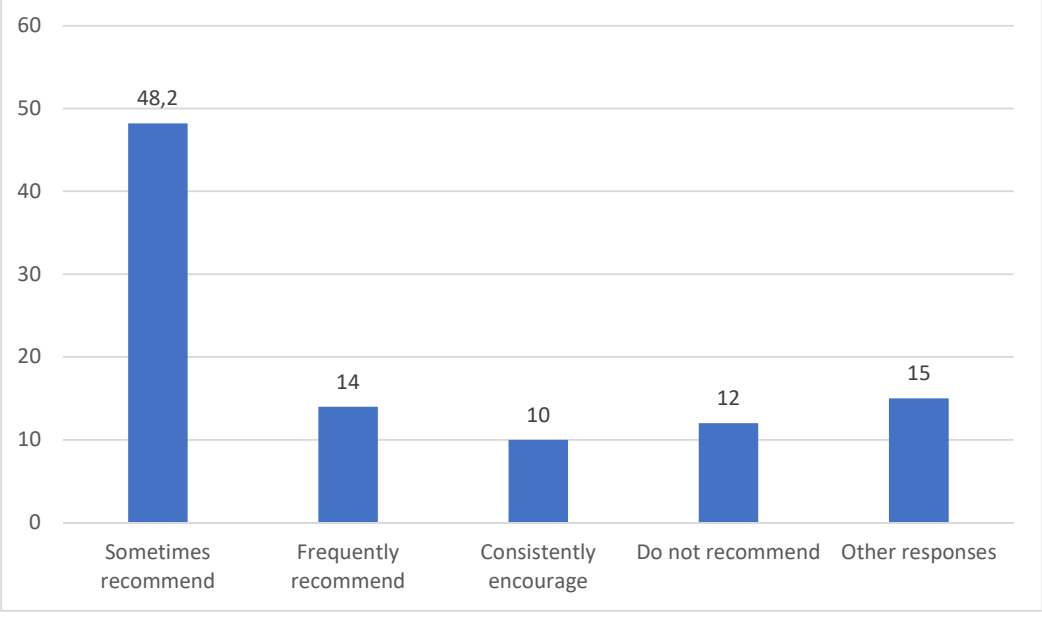
Barriers to using AI in education



The analysis of barriers to AI implementation, presented in Figure 4, revealed several challenges. The most frequently reported obstacle was insufficient technical support (35%), followed by concerns regarding information security and data privacy (31%). In addition, 24% of participants identified the complexity of AI systems as a significant barrier to effective implementation. Other concerns, including limited access to AI tools and insufficient training opportunities, were reported by 5% of respondents. These results indicate that technological and organizational factors continue to influence the successful integration of AI into educational environments.

Figure 5

Recommendations for using supplementary learning materials with ChatGPT



The findings shown in Figure 5 demonstrate students' attitudes toward the use of supplementary learning materials alongside ChatGPT. Nearly half of the respondents (48.2%) reported that they sometimes recommend additional learning resources when using ChatGPT. Furthermore, 14.0% frequently recommend supplementary materials, while 10.2% consistently encourage their use. Conversely, 12.6% of students reported that they do not recommend additional resources, suggesting confidence in ChatGPT as a standalone educational tool. Overall, the results indicate that students recognize the value of combining AI technologies with traditional educational materials to enhance learning outcomes.

Table 1

Likert scale summary table

Questions	Group 1	Group 2	Group 3	Group 4
How would you evaluate the use of artificial intelligence (AI) technologies in the educational process? (1,1)	15	28	21	20
How would you evaluate the use of AI technologies in the educational process? (2,1)	15	28	23	24
What is your opinion on the impact of ChatGPT or other AI tools on improving the learning process? (3,1)	16	17	19	19
What is your opinion on the effectiveness of using AI tools like ChatGPT? (3,1)	7	8	13	15
What is your opinion on the effectiveness of using AI tools like ChatGPT? (3,1)	7	8	13	15
How effective do you think using AI tools like ChatGPT is in increasing academic motivation? (3,2)	14	15	19	19
How effective do you think using AI tools like ChatGPT is in increasing academic motivation? (3,2)	14	15	19	19
How effective is AI in adapting the educational process to meet the individual needs of students? (3,3)	18	15	16	16

How effective is AI in adapting the educational process to meet the individual needs of students? (3,3)	14	17	14	19
How much does using ChatGPT tools help students improve their independent learning skills? (3,4)	11	12	12	14
How much does using ChatGPT tools help students improve their independent learning skills? (3,4)	11	12	12	14
What recommendations would you make for integrating AI tools into the education system? (3,5)	7	10	10	11
What recommendations would you make for integrating AI tools into the education system? (3,5)	7	10	10	11
Would you provide additional learning materials to students when using ChatGPT? (3,7)	3	5	5	5
Would you provide additional learning materials to students when using ChatGPT? (3,7)	2	3	7	4

The Likert-scale analysis presented in Table 1 revealed generally positive attitudes toward AI technologies across all respondent groups. Groups 2 and 4 demonstrated the highest levels of agreement regarding the educational value of AI and ChatGPT. Participants in these groups consistently selected higher-scale responses, indicating stronger support for AI integration. In contrast, Group 1 displayed more cautious attitudes, often selecting lower-scale responses. Group 3 exhibited greater variability in responses, suggesting diverse perspectives regarding the role of AI in education.

Table 2

T-test Results Summary for Comparing Groups

Question	Group 1 vs Group 2	Group 1 vs Group 3	Group 1 vs Group 4	Group 2 vs Group 3	Group 2 vs Group 4	Group 3 vs Group 4
Q1	1.13062, 0.1930	2.05515, 0.04109	0.24412, 0.04112	1.4674, 0.8277	0.83084, 0.8376	1.9278, 0.109824
Q2	0.00825, 0.9934	0.01492, 0.9934	0.00896, 0.9932	0.00681, 0.9937	0.00272, 0.9937	0.02327, 0.9937
Q3	0.14772, 0.6991	0.28023, 0.4994	0.18541, 0.5453	0.13553, 0.6997	0.11267, 0.6967	0.40042, 0.1927
Q4	nan, nan	nan, nan	nan, nan	nan, nan	nan, nan	nan, nan
Q5	0.11602, 0.9301	0.39401, 0.3321	0.28062, 0.4892	0.20862, 0.5914	0.29752, 0.4928	0.28607, 0.4972
Q6	0.46620, 0.6491	0.48151, 0.6387	0.12718, 0.8997	0.12497, 0.8997	0.12982, 0.8997	0.12982, 0.8997
Q7	0.34920, 0.7327	0.49531, 0.6397	0.29198, 0.7279	0.43563, 0.6094	0.30966, 0.7267	0.44242, 0.6357
Q8	0.08921, 0.9825	0.02931, 0.9987	0.02984, 0.9986	0.06894, 0.9875	0.13894, 0.9762	0.12674, 0.9842
Q9	0.89510, 0.3765	0.40016, 0.8528	0.47984, 0.8202	0.39384, 0.8475	0.38984, 0.8427	0.44242, 0.6357
Q10	0.42404, 0.9017	1.27277, 0.0000	1.11451, 0.0000	0.98984, 0.12992	1.2277, 0.0000	1.2277, 0.0000

The t-test results presented in Table 2 indicate that statistically significant differences between groups were limited. Most group comparisons produced p-values greater than 0.05, suggesting

that perceptions of AI technologies were largely consistent across the sample. Significant differences were observed only for selected items, particularly those related to perceptions of AI implementation in education. These findings suggest that although minor variations exist among respondent groups, overall attitudes toward AI remain relatively homogeneous.

Table 3

ANOVA results summary for comparing groups

Comparison	F-statistic	P-value
Comparison for Q1	1.62762	0.18790
Comparison for Q2	NaN	NaN
Comparison for Q3	1.25524	0.29602
Comparison for Q4	NaN	NaN
Comparison for Q5	NaN	NaN
Comparison for Q6	0.51656	0.67166
Comparison for Q7	0.19931	0.89668
Comparison for Q8	0.92291	0.43243
Comparison for Q9	0.36147	0.78102
Comparison for Q10	0.83236	0.48631

Similarly, the ANOVA results presented in Table 3 confirmed the absence of substantial differences among groups. For most survey items, p-values exceeded the conventional significance threshold of 0.05, indicating that respondents shared comparable perceptions regarding the effectiveness, usefulness, and educational value of AI technologies. The findings therefore demonstrate a broad consensus concerning the positive role of AI in contemporary educational practice. Overall, the results indicate that students hold favorable attitudes toward artificial intelligence and recognize its potential to improve learning quality, support personalized instruction, increase academic motivation, and facilitate cognitive skill development. At the same time, participants emphasized the importance of addressing technical, organizational, and ethical challenges to ensure successful implementation of AI technologies within educational settings.

Discussion. The purpose of this study was to investigate students' perceptions of artificial intelligence technologies and their application within educational environments. The findings demonstrate that students generally hold positive attitudes toward AI integration and recognize its potential to enhance learning experiences, improve academic performance, and support personalized education. One of the most significant findings of the study is the widespread use of AI technologies among future teachers. The majority of participants reported moderate or intensive use of AI tools, indicating that these technologies are becoming increasingly embedded within higher education. This trend reflects the growing digitalization of educational processes and the expanding role of AI-supported learning environments.

The results further revealed that students perceive ChatGPT as an effective educational resource. Participants emphasized its contribution to creativity, learning efficiency, and academic motivation. These findings are consistent with previous studies suggesting that AI-powered tools facilitate personalized learning experiences and provide learners with immediate access to educational support. The positive evaluations observed in the present study indicate that students increasingly view AI as a valuable complement to traditional teaching methods rather than a replacement for educators. The findings regarding cognitive skill development are particularly noteworthy. Most respondents identified personalized learning as the primary advantage of AI technologies. This supports contemporary educational theories emphasizing learner-centered instruction and

adaptive learning environments. AI systems enable students to receive individualized feedback, monitor their progress, and access educational content tailored to their specific needs, thereby enhancing self-regulated learning and academic achievement.

At the same time, the study identified several barriers that may limit the effective implementation of AI technologies. Technical support deficiencies, information security concerns, and system complexity emerged as the most frequently reported challenges. These findings highlight the importance of developing institutional infrastructure, providing professional training, and establishing clear ethical guidelines for AI use in education. Without addressing these issues, the full educational potential of AI technologies may not be realized. The present findings support the conclusions of Akgun and Greenhow (2021), who emphasized the need to carefully consider the ethical implications of AI use in educational settings. Concerns regarding excessive reliance on AI technologies and their potential influence on critical thinking remain important considerations for educational policymakers and practitioners. At the same time, the findings are also consistent with Haleem et al. (2022), who reported that AI technologies contribute positively to personalized learning, student engagement, and educational outcomes.

The statistical analyses further strengthen the interpretation of the results. Both t-test and ANOVA findings demonstrated that students from different groups generally share similar perceptions regarding AI technologies. The absence of substantial differences across groups suggests that positive attitudes toward AI are widespread and not limited to specific subpopulations of students. This consistency indicates a growing acceptance of AI as a legitimate and beneficial educational tool. Overall, the findings suggest that artificial intelligence has considerable potential to enhance educational quality, support inclusive learning environments, and promote students' cognitive and academic development. Future research should focus on examining long-term educational outcomes associated with AI implementation, exploring teachers' readiness to integrate AI technologies, and developing evidence-based strategies for addressing technical and ethical challenges. Such efforts will contribute to the effective and responsible integration of artificial intelligence into modern educational systems.

Conclusion. The introduction of artificial intelligence technologies such as ChatGPT into education opens new opportunities for improving learning quality, student engagement, and cognitive development. AI supports personalized learning by adapting educational content to individual student needs, which can enhance efficiency, analytical thinking, and critical skills. However, despite its advantages, the integration of AI into education raises important strategic and ethical questions, including academic integrity, data privacy, and algorithmic bias. In addition, limitations such as insufficient technical infrastructure and unequal access to digital resources remain significant barriers to full implementation. This study analyzes students' use of ChatGPT and other AI tools in academic settings and evaluates their impact on creativity and cognitive skills. The findings suggest both positive outcomes and existing challenges in AI-supported learning environments. Effective integration of AI requires not only technological development but also strong ethical guidelines and pedagogical frameworks. AI should complement, not replace, traditional teaching methods, preserving the human aspect of education and supporting the development of independent learners.

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Original Article

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Features of Training Future Physical Education Teachers based on the Co-Teaching Method in Inclusive Education

Abstract

Introduction. This article addresses the issue of preparation of future physical education teachers in inclusive education settings requires innovative pedagogical approaches that ensure all students, regardless of their abilities, receive equitable learning opportunities. *Methodology and methods.* The research employed a mixed-methods design combining quantitative and qualitative approaches. The study involved undergraduate students majoring in physical education who participated in experimental training focused on co-teaching practices in inclusive settings. In this study, several research methods, including pedagogical observation, student surveys, analysis of reflective journals, and assessment of professional competencies before and after the implementation of the co-teaching approach were applied. To determine the effectiveness of the intervention, statistical analysis was conducted to compare changes in students' preparedness for inclusive teaching and collaborative professional work. *Results.* Analysis of the results showed that co-teaching had a positive influence on the professional development of future physical education teachers. Students became more confident in organizing inclusive lessons, interacting with peers, and adapting teaching strategies to different learners' needs. The study also identified several factors that played an important role in the success of co-teaching. Among them were joint lesson preparation, clearly defined responsibilities between teaching partners, collaborative decision-making, and regular reflection on classroom experiences. At the same time, participants reported a number of difficulties, particularly at the initial stage of implementation. *Scientific novelty*. The study's novelty lies in the substantiation of co-teaching as an effective pedagogical technology for preparing future physical education teachers specifically for inclusive educational environments. This research expands existing approaches to teacher preparation by integrating collaborative instructional models into physical education pedagogy and identifying organizational and methodological conditions necessary for successful implementation. *Practical significance.* The present study is associated with the possibility of applying the proposed co-teaching model in higher education institutions that train future teachers. The obtained results can be used in the development of educational programs, teaching practice modules, and professional development courses aimed at strengthening inclusive competence.

Keywords: co-teaching, inclusive education, physical education, teacher training, collaborative teaching, professional competencies.

Introduction. In the contemporary global educational space, one of the central priorities is the creation of an educational environment that enables every specialist to continuously enhance professional qualifications and acquire the competencies required for effective practice.

Inclusive education has become one of the leading priorities of contemporary educational policy worldwide, emphasizing equal access to quality education for all learners regardless of their individual characteristics and educational needs. The successful implementation of inclusive education requires not only the

adaptation of educational environments but also the preparation of teachers capable of working effectively in diverse classrooms. In this regard, the training of future physical education teachers acquires particular significance, as physical education lessons involve intensive social interaction, cooperation, and adaptation of learning activities to students with different abilities.

In Kazakhstan, the development of inclusive education is supported by a comprehensive legislative framework. The Law of the Republic of Kazakhstan "On Education" emphasizes the principles of accessibility, equality, and the creation of conditions for obtaining quality education by all citizens, including learners with special educational needs (Republic of Kazakhstan, 2007). Further strengthening of inclusive practices was reflected in legislative amendments aimed at expanding educational opportunities and social support mechanisms for persons with special educational needs (Republic of Kazakhstan, 2021). These reforms highlight the necessity of preparing future teachers who possess inclusive competencies and can effectively collaborate with other educational professionals.

One of the most promising approaches for teacher preparation in inclusive settings is the co-teaching method. Co-teaching refers to the collaborative work of two or more educators who share responsibility for planning, delivering, and assessing instruction within the same educational environment. According to Friend and Cook (2017), effective collaboration among educational professionals enhances instructional quality, supports differentiated learning, and promotes positive educational outcomes for all students. The co-teaching model enables future teachers to develop communication skills, professional flexibility, and the ability to address diverse learner needs through shared expertise and collective decision-making.

For future physical education teachers, co-teaching offers additional opportunities to master inclusive pedagogical strategies, adapt physical activities, and create supportive learning environments that encourage participation and engagement of students with varying physical, cognitive, and social abilities. Through collaborative practice, teacher candidates gain practical experience in teamwork, reflective decision-making, and individualized instruction, all of which are essential components of inclusive physical education.

Despite the growing recognition of co-teaching in inclusive education, there remains a need to examine its specific role in the preparation of future physical education teachers. Therefore, this study aims to explore the features and pedagogical potential of training future physical education teachers based on the co-teaching method within the context of inclusive education.

In Kazakhstan, inclusive education has been developing steadily and is supported by several important legislative and conceptual reforms.

These include the introduction of the concept of inclusive education into the Law "On Education of the Republic of Kazakhstan" in 2011, the approval of comprehensive measures for inclusive education in 2014, the adoption of conceptual approaches to its development in 2015, the enactment of a specific law on inclusive education in 2021, the shift from a medical to a socio-pedagogical model, and the implementation of continuous support for inclusive and special education in 2023. On the whole, these changes have initiated a large-scale transformation of the national system of specialist training, moving it from a deficit-based medical model toward a socially oriented model that emphasizes participation, accessibility, and equal opportunities.

Research on inclusive education consistently emphasizes that successful inclusion depends on meaningful collaboration between teachers and the creation of supportive learning environments. Early studies demonstrated that cooperative teaching enhances instructional flexibility and promotes positive professional relationships among educators (Salend et al., 1997).

The co-teaching model has been recognized as one of the most effective approaches for supporting students with special educational needs in mainstream classrooms. Effective implementation of co-teaching contributes to

academic achievement, social participation, and differentiated instruction (Villa et al., 2013).

Empirical evidence suggests that students with learning disabilities demonstrate better educational outcomes when instruction is delivered through collaborative and inclusive teaching models rather than through segregated support systems (Tremblay, 2013).

Recent studies have highlighted the importance of preparing future teachers for equitable and inclusive educational practices. Teacher education programmes should provide opportunities for developing competencies related to diversity, participation, and educational equity (Pereira Ribeiro et al., 2024).

Current research also demonstrates that collaborative skills can be effectively developed through innovative training formats, including simulation-based learning environments, which help future teachers master interaction and teamwork skills required in inclusive classrooms (Qualls et al., 2025).

Recent studies conducted in Kazakhstan confirm the growing importance of co-teaching as an effective mechanism for implementing inclusive education. The co-teaching model contributes to the development of professional collaboration, emotional support, and pedagogical flexibility among future teachers, thereby improving their readiness to work in diverse educational environments (Ospankulov et al., 2025).

This transformation has created an urgent demand for highly qualified professionals who are capable of working in inclusive environments and who possess a broad range of professional, methodological, and interpersonal competencies. The development of inclusive policy, inclusive culture, and inclusive practice has therefore become a strategic priority for every educational organization. At the same time, the growing complexity of inclusive education increases the need for innovative methodological approaches in teacher education, which further strengthens the relevance of this research. In addition to subject-specific and practical teaching skills, future teachers must also develop digital literacy, innovative thinking, and creative decision-making abilities that are essential for working in diverse and dynamic inclusive learning environments. To fully implement the principles of inclusive education, teachers require specialized methodological competencies and universal skills that allow them to respond flexibly to the needs of learners with different educational abilities and conditions.

The comprehensive preparation of future teachers involves a wide range of professional disciplines aimed at integrating psychological, theoretical, social, and practical components of training. Psychological preparation is directed toward fostering sustained motivation for working in inclusive settings and promoting effective interaction with learners with special educational needs and their families. Theoretical preparation equips future teachers with knowledge about learner diversity and the specific characteristics that must be considered in educational planning. Social and practical preparation, in turn, provides psychological, pedagogical, and methodological skills that support productive communication, collaboration, and professional interaction in inclusive contexts.

Research indicates that the effectiveness of inclusive education largely depends on the quality of collaboration between general and special education teachers. Co-teaching models create opportunities for shared responsibility, differentiated instruction, and improved educational outcomes for learners with diverse needs (McLeskey & Waldron, 2007).

Studies have demonstrated that successful implementation of inclusive practices requires systematic professional development and the formation of collaborative competencies among teachers. Positive relationships have been found between co-teaching experience, professional confidence, and teachers' willingness to implement inclusive strategies (Pancsofar & Petroff, 2016).

The development of collaborative teaching practices is associated with higher levels of instructional adaptation and student engagement in inclusive classrooms. Effective teacher partnerships contribute to the creation of supportive learning environments and increased participation of students with special educational needs (Jurkowski et al., 2020).

According to Albaiz (2016), co-teaching represents one of the most promising approaches for ensuring educational equity and addressing diverse learning needs within mainstream classrooms.

Recent studies continue to emphasize the importance of collaborative cultures in schools and the need for institutional support mechanisms that facilitate teacher cooperation and inclusive pedagogical practices (Damiani & Drelick, 2024).

International research also emphasizes the decisive role of future teachers in creating accessible, supportive, and equitable learning environments. Scholars highlight that teacher preparation must ensure the acquisition of relevant knowledge, the development of professional skills, and the formation of values and attitudes oriented toward recognizing and respecting the needs of learners with special educational needs (Rodríguez Herrero et al., 2023). However, despite growing recognition of inclusivity, some higher education programs still do not fully integrate inclusive competencies into teacher training, leaving graduates insufficiently prepared for professional practice in diverse educational settings. Consequently, teacher education must go beyond theoretical instruction and place greater emphasis on practical training, the development of flexible skills, and the effective use of innovative and digital technologies. Moreover, personal qualities such as patience, emotional stability, and professional commitment are also critical for future teachers working in inclusive environments, as demonstrated in recent studies.

The Co-Teaching Model is used in all educational institutions, in various subject areas and directions, and in the process of training future teachers. The Co-Teaching Model is often defined as a collaborative practice, during which lesson plans are created together, work is carried out with students, and the work is assessed. The vast majority of research on inclusive education focuses on the process of accessible education for students, and in inclusive education, co-teaching describes the relationship between special education teachers and general education teachers, although it can be carried out between all teachers. To summarize the research, the Co-Teaching Model is widely used in all educational organizations; there are many types of interaction within this model. In our case, the Co-Teaching Model is an effective relationship between a future special education teacher and a future primary education teacher, a future physical education and sports teacher, that is, joint action based on the principles of the model.

Analyzing the research premises, we can conclude that inclusive education requires a high level of professional partnership and cooperation from future teachers and the ability to build effective joint action in the educational environment. Given the relevance of the integration of students with special needs, the relevance of studying the psychological and pedagogical aspects that affect the formation of professional activity of future teachers on a joint basis has been clearly demonstrated. Scientists have identified the conditions for co-teaching success. One of these is the combination of team teaching and individual lessons. The next condition is minimal theoretical preparation for the new role and the study of co-teaching models. The final determining factor for success is the ability to choose a colleague to teach in the team. Thus, co-teaching has great potential and has a beneficial impact on all participants in the educational process. However, for this method to be successful, the following conditions must be implemented in the educational system: professional development for teachers, sufficient time for joint planning, compatibility between teachers, and administrative support from the educational institution's leadership. It should also be noted that the full potential of team teaching is poorly understood. More qualitative and quantitative research is needed, including long-term observations of teaching teams at all stages of education, from primary school to continuing adult education. Only through such research will it be possible to determine the effectiveness of co-teaching.

Taking into account what we have indicated above, physical education (PE) teachers face unique challenges, as they work with students of varying abilities in dynamic, activity-based

settings. Effective preparation of future PE teachers requires the development of practical, methodological, and interpersonal skills that enable them to design inclusive learning experiences. One of the promising approaches is the co-teaching method, which involves collaboration between two or more educators in the same educational space. Co-teaching fosters shared responsibility, adaptive teaching strategies, and individualized support for students, making it a particularly effective model for inclusive physical education. Our article explores the features of training future physical education teachers using the co-teaching method in inclusive education. It examines the competencies required, the mechanisms of implementing co-teaching in teacher education, and the challenges and opportunities associated with preparing educators for inclusive practice. The main aim of our findings is to provide insights into effective strategies for developing highly qualified, socially responsive, and professionally competent PE teachers ready to work in an inclusive educational environment.

Materials and Methods. The study employed a mixed-methods approach, combining qualitative and quantitative methods to investigate the features of training future physical education (PE) teachers using the co-teaching method in inclusive education settings. The research design allowed us to gain a comprehensive understanding of both the perceptions of teacher trainees and the effectiveness of co-teaching strategies in practical pedagogical contexts.

Participants. The study involved 120 undergraduate students enrolled in the Physical Education program at a leading pedagogical university in Kazakhstan. Participants were in their third and fourth years of study and had completed foundational courses in pedagogy, inclusive education, and physical education methodologies. The sample was selected using a purposive sampling strategy, based on clearly defined inclusion criteria, namely: (1) enrollment in the PE teacher education program, (2) completion of prerequisite pedagogical and inclusive education courses, and (3) willingness to participate in the co-teaching intervention and related data collection procedures. Students who did not meet the established criteria or were unable to complete all stages of the intervention were not included in the study. This approach allowed us to work with participants who possessed the necessary theoretical knowledge and a sufficient level of practical preparedness for participation in co-teaching activities in inclusive physical education classes. The final sample consisted of 120 students, including 65 female and 55 male participants aged from 20 to 24 years.

Data collection tools. Several complementary instruments were employed to collect data. First, a structured questionnaire was developed to assess participants' perceptions of their readiness to work in inclusive PE classrooms. The questionnaire consisted of 25 items organized into four domains: inclusive pedagogical knowledge, confidence in adapting physical education activities, classroom management in diverse groups, and collaboration with other professionals. Responses were measured using a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The questionnaire was administered before and after the co-teaching intervention to identify changes in participants' self-assessments. Second, classroom observation protocols were used during teaching practicum sessions. These protocols enabled supervisors to document participants' instructional behaviors, communication patterns, adaptation strategies, and interactions with students with diverse educational needs. Particular attention was paid to how trainee teachers shared instructional responsibilities, managed classroom activities, and responded to challenges emerging in inclusive environments. Third, reflective journals were maintained by all participants throughout the practicum period. After each co-taught lesson, trainees recorded their observations, difficulties encountered, successful teaching strategies, and personal reflections on collaborative work. These journals provided valuable information about the developmental process that could not be captured through quantitative measures alone.

Data collection procedure. The study was conducted over one academic semester and

involved undergraduate students enrolled in a teacher education program specializing in physical education. Before the intervention, participants completed the baseline questionnaire measuring their preparedness for inclusive teaching. The co-teaching intervention was then integrated into the teaching practicum component of the program. Participants were organized into teaching pairs and assigned to inclusive school settings where they collaboratively planned, delivered, and evaluated physical education lessons. During the initial stage, trainees received orientation sessions introducing the principles of co-teaching, including collaborative planning, shared responsibility, role distribution, and reflective practice. Throughout the practicum, participants engaged in multiple co-taught lessons under the supervision of university instructors and school mentors. Supervisors conducted systematic observations using standardized observation protocols. Following each teaching session, trainees completed reflective journal entries documenting their experiences and professional learning. At the end of the practicum period, participants completed the post-intervention questionnaire. Subsequently, semi-structured interviews were conducted with selected participants representing different levels of teaching experience and engagement in the program. The combination of questionnaires, observations, journals, and interviews enabled methodological triangulation and enhanced the credibility of the findings.

The study was organized in three consecutive phases. During the preparatory phase, we examined theoretical and methodological literature, as well as national and international policy documents related to inclusive education and the co-teaching approach. Particular attention was paid to current practices of preparing future teachers for work in inclusive educational environments. The co-teaching program developed for future physical education teachers was mainly focused on practical experience and real classroom interaction. Its structure combined several closely related components: collaborative lesson preparation, the use of differentiated teaching methods, and adaptation of assessment approaches for inclusive physical education classes. Throughout the program, students worked in pairs. In some cases, they collaborated with another trainee, while in others, they were paired with an experienced instructor. Such an organization made it possible to provide support at the early stages and then gradually increase the level of independence and responsibility. Practical training took place in inclusive physical education classes attended by learners with different educational and physical needs, including students with motor coordination difficulties, physical disabilities, and different levels of physical preparedness.

The lessons themselves were not conducted according to rigid scripts. Before each class, participants discussed lesson objectives together, distributed responsibilities, and decided how they would organize interaction with students during activities. During the lessons, teaching roles changed naturally depending on the situation: one participant could lead the activity while the other assisted individual learners, after which they switched responsibilities. This flexible cooperation helped trainees better understand how to adapt instruction in real classroom conditions and respond to students' needs more effectively.

An important part of the program was the discussion held after each lesson. Students reflected on situations that occurred during the class, analyzed the effectiveness of their teaching decisions, and discussed difficulties they encountered while working together. These conversations often influenced the planning of the next lesson, allowing participants to gradually improve their communication, teaching strategies, and ability to work collaboratively in inclusive settings. To assess the effectiveness of the program, pre- and post-intervention surveys were conducted. The questionnaires examined changes in students' perceived readiness for inclusive teaching, their confidence in working collaboratively with colleagues, and their ability to apply differentiated instructional strategies in diverse educational contexts. Observational checklists were used to assess the quality of co-teaching practices during PE classes, including communication, teamwork, and the ability to

provide individualized support. Semi-structured interviews with trainees and instructors explored perceptions of the challenges and benefits of co-teaching in inclusive PE settings. Surveys: A structured questionnaire assessed trainees' knowledge of inclusive pedagogy, confidence in co-teaching, and perceived readiness to teach in inclusive settings. The reliability of the instrument was verified with Cronbach's alpha = 0.87.

The research used structured observation checklists developed on the basis of internationally recognized inclusive education and teacher competency frameworks. In particular, the indicators were aligned with the principles of the UNESCO (2009) Policy Guidelines on Inclusion in Education, which emphasize participation, accessibility, and responsive teaching practices in diverse classrooms. In addition, the checklist design was informed by the European Agency for Special Needs and Inclusive Education (2012) framework on teacher competences for inclusive education, which highlights collaboration, learner diversity, and reflective practice as core professional domains. To further operationalize classroom-level teaching behaviors, we also drew on the Danielson Framework for Teaching (Danielson, 2013), particularly the domains related to instructional planning, classroom environment, and professional responsibilities. Collaboration indicators were additionally informed by co-teaching models proposed by Cook (1992**)**, while differentiation and adaptive instruction criteria were based on principles outlined by Tomlinson (2014) in differentiated instruction. Accordingly, the final observation checklist evaluated four key dimensions during PE lessons: collaboration between co-teachers, student engagement, differentiation of instruction, and problem-solving in real-time instructional situations. All interviews were conducted with open-ended questions to capture qualitative insights regarding the implementation of co-teaching, challenges faced, and strategies developed by trainees.

Data analysis. Quantitative data from surveys and observations were analyzed using descriptive statistics, paired t-tests, and correlation analysis to determine changes in competencies before and after the co-teaching intervention. Qualitative data from interviews were analyzed using thematic content analysis, identifying recurring patterns, challenges, and effective strategies in co-teaching. Triangulation of qualitative and quantitative data ensured the reliability and validity of the results.

Limitations. The present study was limited to one university in Kazakhstan, and the sample size may not fully represent all PE teacher trainees nationwide. Additionally, the co-teaching intervention was conducted over a single semester, which may limit the observation of long-term effects on teaching competencies.

Results. *Self-Assessment of Inclusive Competencies.* Trainees completed pre- and post-intervention surveys measuring self-assessed competencies in inclusive teaching, collaboration, and adaptive instructional strategies. Table 1 shows the results:

Table 1

Changes in students' self-assessed competencies before and after the co-teaching intervention

Competency Area	Pre-test Mean ± SD	Post-test Mean ± SD	t-value	df	p-value
Knowledge of Inclusive Pedagogy	3.12 ± 0.68	4.21 ± 0.55	12.48	119	< 0.001
Confidence in Co-Teaching	2.87 ± 0.74	4.05 ± 0.61	13.02	119	< 0.001
Adaptive Instruction Skills	3.05 ± 0.70	4.17 ± 0.53	12.67	119	< 0.001
Collaboration & Teamwork	3.24 ± 0.65	4.32 ± 0.49	14.05	119	< 0.001

The results show a clear and statistically significant improvement in all assessed competency areas following participation in the co-teaching program. The greatest improvement was noticed in students' ability to work together and coordinate their actions during lessons.

Regular participation in shared teaching activities helped them communicate more confidently, distribute responsibilities more effectively, and respond more flexibly to situations that emerged in inclusive physical education classes. Over time, many trainees became more comfortable discussing problems, making joint decisions, and supporting each other during the lesson process.

To evaluate how students applied co-teaching in practice, their work during physical education classes was systematically observed. Special observation checklists were used during lessons to record different aspects of teaching behavior, interaction with learners, classroom communication, and the use of adaptive teaching strategies. Since the observations were conducted directly in real classroom situations, they made it possible to see how trainees reacted to students' needs and how effectively they cooperated with their teaching partners in practice. Particular attention was paid to how effectively students prepared and implemented lesson plans, the extent to which they engaged learners in physical activities, and their ability to adapt instruction to different levels of ability within the same class. In addition, evaluators focused on trainees' responsiveness in unexpected situations, especially their problem-solving skills when managing classroom dynamics or modifying tasks on the spot. Table 2 summarizes the average ratings obtained across these key indicators.

Table 2

Observational assessment of co-teaching performance (scale 1–5, n=120)

Indicator	Mean ± SD
Lesson Planning & Preparation	4.18 ± 0.51
Student Engagement	4.25 ± 0.48
Differentiation of Instruction	4.10 ± 0.53
Communication & Collaboration	4.34 ± 0.44
Problem-Solving in Inclusive Settings	4.12 ± 0.50

Observation results suggest that trainees were generally able to apply co-teaching strategies in a meaningful way, particularly when it came to supporting student engagement and adjusting activities to the diverse needs present in inclusive PE classes. Among the assessed indicators, communication and collaboration stood out most clearly, which, in our view, reflects the consistent emphasis placed on shared responsibility and teamwork throughout the co-teaching process. In addition, the thematic analysis of semi-structured interviews with both trainees and instructors allowed us to identify three interrelated themes.

First, many trainees described a noticeable increase in self-confidence when working in inclusive PE settings. They repeatedly noted that co-teaching created a kind of "safety net," where they felt more comfortable trying out new instructional approaches, knowing that support and immediate feedback from a peer or mentor was available. Second, participants emphasized the development of adaptive teaching skills. In our study, trainees often emphasized that observing a co-teaching partner in real time was one of the most useful aspects of the experience. It allowed them to see, in practice, how instructional decisions can be adjusted on the spot- for example, changing the pace of activities, modifying task complexity, or rephrasing explanations depending on students' responses and individual needs.

At the beginning of the program, many students faced certain difficulties while working in pairs. Some participants found it hard to divide responsibilities during the lesson or agree on who should lead particular activities. In several cases, communication between partners was not always smooth, which sometimes affected the overall organization of the class. Students also mentioned that managing lesson time in a co-teaching format was more complicated than they had expected. As the training continued, these issues became less noticeable. Regular joint

lesson preparation and discussions after classes helped participants better understand each other's working styles and improve coordination during teaching. Gradually, students became more confident in planning together, responding to unexpected situations, and maintaining communication throughout the lesson.

Overall, the results suggest that co-teaching is a promising approach for preparing future physical education teachers for inclusive classroom environments. The quantitative findings indicate improvements in knowledge, confidence, collaboration, and adaptive instructional skills, while the observational data support these results, showing that many of these competencies were increasingly applied in real teaching practice. At the same time, qualitative feedback highlights the importance of mentorship, peer learning, and joint problem-solving as key mechanisms of professional growth.

These results are in line with international studies that emphasize co-teaching as a powerful model for developing inclusive pedagogical competence (Cook, 1992; Murawski & Bernhardt, 2015). In the context of Kazakhstan, where inclusive education is still in a phase of active development, we believe that the systematic integration of co-teaching into teacher education programs may significantly contribute to preparing more competent and socially responsive physical education teachers. Finally, our study also highlights several practical conditions that appear essential for successful implementation. In particular, structured planning sessions, clearly defined role distribution, and regular reflective discussions were crucial in helping trainees overcome initial coordination difficulties and gradually build effective co-teaching partnerships. Moreover, combining theoretical knowledge with hands-on inclusive PE experiences strengthens digital literacy, innovative thinking, and creative problem-solving skills, all of which are crucial for modern educators.

Discussion. In the current global educational landscape, a key priority is the development of learning environments that support continuous professional growth and enable specialists to acquire the competencies required for effective and adaptive practice. Within this context, Kazakhstan has made steady progress in advancing inclusive education, which has been reinforced through a series of legislative and conceptual reforms. Over the last decade, inclusive education in Kazakhstan has undergone several important changes at the legislative and policy levels. In 2011, the principles of inclusive education were officially incorporated into the Law "On Education of the Republic of Kazakhstan." A few years later, national measures aimed at supporting the implementation of inclusive practices began to be introduced. Further development continued with the preparation of conceptual documents in 2015 that outlined the main directions of inclusive education policy. In 2021, a separate law dedicated specifically to inclusive education was adopted, which strengthened the legal basis for supporting learners with diverse educational needs.

At the same time, the understanding of inclusion itself also started to change. Educational policy gradually moved away from a mainly medical interpretation of disability toward a socio-pedagogical approach that places greater attention on participation, accessibility, and educational support. More recently, continuous support systems for inclusive and special education were introduced, expanding assistance for both learners and teachers within educational institutions. Together, these reforms reflect a systemic shift in how specialist training is conceptualized, moving away from deficit-oriented perspectives toward a more holistic, socially grounded understanding of participation and equity. Against this background, there is a clear and growing demand for professionals who are not only well-trained but also capable of functioning effectively in inclusive educational settings. This requires a combination of professional expertise, methodological flexibility, and strong interpersonal competencies. As inclusive education becomes more deeply embedded in educational policy and institutional practice, the development of an inclusive culture has emerged as a strategic objective across all levels of the education system.

At the same time, the increasing complexity of inclusive classrooms places new demands on teacher education programs. It is no longer sufficient for future teachers to master only subject knowledge and routine pedagogical techniques. They are now expected to demonstrate digital literacy, creative and critical thinking, and the ability to make informed instructional decisions in rapidly changing and diverse learning contexts. In this sense, effective preparation for inclusive education depends on the formation of both specialized methodological competencies and broader transferable skills that enable teachers to respond sensitively and flexibly to the varied needs of learners.

The comprehensive preparation of future teachers involves a wide range of professional disciplines aimed at integrating psychological, theoretical, social, and practical components of training. Psychological preparation is directed toward fostering sustained motivation for working in inclusive settings and promoting effective interaction with learners with special educational needs and their families. Theoretical preparation equips future teachers with knowledge about learner diversity and the specific characteristics that must be considered in educational planning. Social and practical preparation, in turn, provides psychological, pedagogical, and methodological skills that support productive communication, collaboration, and professional interaction in inclusive contexts.

International research also emphasizes the decisive role of future teachers in creating accessible, supportive, and equitable learning environments. Scholars highlight that teacher preparation must ensure the acquisition of relevant knowledge, the development of professional skills, and the formation of values and attitudes oriented toward recognizing and respecting the needs of learners with special educational needs (Rodríguez Herrero et al., 2023). At the same time, the importance of taking into account learners' individual characteristics, preventing potential barriers to participation, and anticipating negative influences on learning has been stressed, which requires a comprehensive and proactive approach to educational support. Adaptation and individualization of curricula, along with their continuous refinement in line with students' characteristics and evolving professional demands, are widely recognized as key conditions for ensuring the quality of inclusive education. In practice, this means that curricula cannot remain static; they require constant adjustment depending on classroom dynamics and learner diversity.

Future teachers are therefore expected to develop the ability to recognize and address emotional, social, and physical barriers that may restrict students' participation. These barriers are often subtle and context-dependent, which makes the teacher's sensitivity and responsiveness particularly important in inclusive settings. At the same time, it should be noted that not all higher education programs have fully embedded inclusive competencies into their teacher training frameworks. As a result, some graduates still enter the profession without sufficient practical readiness for work in diverse classrooms. This gap suggests that teacher education needs to move beyond predominantly theoretical preparation and place greater emphasis on practice-oriented training, the development of flexible pedagogical skills, and meaningful engagement with digital and innovative teaching tools.

Existing research also consistently shows that successful work in inclusive classrooms depends not only on methodological knowledge, but also on certain personal and professional qualities of the teacher. Traits such as patience, emotional balance, empathy, and a well-developed sense of responsibility play a decisive role in sustaining productive interactions with diverse learners. In real classroom conditions, these qualities often determine how effectively a teacher can respond to unexpected situations and maintain a supportive learning environment. Our study showed that the inclusion of the co-teaching model in the preparation of future physical education teachers led to positive results. In comparison with traditional forms of training, this approach placed students in situations where they constantly had to work together, discuss lesson organization, divide responsibilities, and make decisions directly

during classroom activities. Such experience helped them better understand the practical side of inclusive teaching.

As the program continued, students became more confident in collaborative work. They planned lessons together more easily, coordinated their actions during classes more effectively, and interacted with learners in a more organized and supportive way. Many participants noted that, with practice, they felt more comfortable adapting tasks and responding to different classroom situations. These changes developed gradually and became more visible after repeated participation in co-teaching lessons. The results of the study, including both statistical data and students' reflections, suggest that regular co-teaching practice helps future teachers feel more prepared for work in inclusive educational settings. Most importantly, it allowed students to connect theoretical knowledge with real teaching experience in the classroom.

Conclusion. The results of our study suggest that co-teaching may serve as an effective approach for overcoming many of the difficulties that arise in the preparation of future teachers. What became clear in practice is that structured collaboration between trainee teachers and experienced instructors gives students something difficult to achieve through lectures alone-real exposure to how inclusive classrooms actually function on a day-to-day basis. Rather than staying at the level of theoretical discussion, trainees are placed in situations where they have to act, respond, and adjust together with a partner. This gradual shift from "knowing about inclusion" to "working within inclusion" appears to be one of the most meaningful outcomes of the approach. An additional and equally important change concerns how trainees begin to interpret student diversity. As they observe inclusive strategies being implemented in real time, and as they participate in joint planning and reflection, many of them start to move away from deficit-oriented assumptions. Instead of focusing on what students "lack," they increasingly focus on what can be adapted, supported, or redesigned in instruction. In this sense, co-teaching not only develops technical teaching skills. It also reshapes how future teachers think about learners, decision-making, and responsibility in the classroom.

The results also show that future teachers' attitudes toward inclusive education vary according to factors such as gender, age, academic specialization, and professional experience. In this regard, the development of social and emotional competencies is particularly important, including self-reflection, professional empathy, and the ability to effectively implement the principles of inclusion in everyday pedagogical practice. The present study explored the distinctive features of preparing future physical education teachers through the co-teaching method within inclusive education. The findings indicate that integrating co-teaching into teacher preparation significantly enhances trainees' professional competencies, confidence, collaborative skills, and adaptive instructional practices. In our study, the quantitative results clearly indicate substantial improvements in trainees' understanding of inclusive pedagogy, their perceived co-teaching efficacy, and their ability to work effectively as part of a teaching team after participating in structured co-teaching experiences.

These outcomes suggest that when co-teaching is not treated as a short-term experiment but is systematically integrated into teacher training, it contributes not only to conceptual understanding but also to the gradual formation of real collaborative competence. In other words, students do not simply learn about cooperation-they begin to practice it in a structured and meaningful way. Overall, our research contributes to a more nuanced understanding of how co-teaching can be intentionally integrated into physical education teacher preparation. We argue that such integration not only strengthens professional readiness for inclusive classrooms but also has broader implications for curriculum development, teacher education practice, and educational policy aimed at promoting equity and inclusion for all learners.

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