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General Information

About the Journal

Abai Journal of Pedagogy and Psychology is a peer-reviewed scientific and methodological journal founded in 2009 by Abai Kazakh National Pedagogical University. The journal focuses on key issues in education at all levels, from early childhood through higher education, and serves as a platform for academic discourse, research dissemination, and professional development in pedagogy and psychology.

Aims and Scope

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.

Editorial Strategy

The editorial board adheres to the following principles:

3. Impartial and objective peer-review process;
4. High standards of scientific rigor and methodological accuracy;
5. Collective decision-making based on expert consensus;
6. Efficient and transparent communication with authors;
7. Full respect for intellectual property rights;
8. Strict adherence to the publication schedule;
9. Limitation of publication frequency to a maximum of two articles per author per calendar year.

Indexing and Recognition

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3. Issue 3 – September
4. Issue 4 – December

Review Process

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Language of Publication

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Bibliometric Analysis of Distance Education Research in Special Education: A Scopus-Based Review

Abstract

Introduction. This study provides a descriptive bibliometric overview of research at the intersection of distance education and special education. The purpose of the study is to describe the publication landscape of this field by examining the basic bibliographic characteristics and temporal development of Scopus-indexed publications. *Methodology and Methods.* Scopus was used as the data source. On September 14, 2026, the terms “distance education” and “special education” were searched together in the “Article Title, Abstract, Keywords” field. The search yielded 123 documents, all of which were included in the analysis without additional filtering or sampling. The records were examined by publication year, subject area, document type, publication language, country, institution, and source type using frequency and percentage distributions. *Results.* Publications spanned 1994–2025, with the highest number recorded in 2022 ($f = 16$; 13.01%); 2016 and 2023 followed with 11 publications each (8.94%). The most prominent subject areas were Social Sciences (73.17%), Computer Science (34.96%), and Psychology (18.70%). Articles accounted for 60.98% of the documents, followed by conference papers (19.51%) and book chapters (10.57%). English was the dominant publication language, appearing in 115 records (93.50%). The United States had the highest publication count ($f = 50$; 40.65%), followed by Brazil, Turkey, and Greece. At the institutional level, West Virginia University had the highest number of publications ($f = 10$). Journals were the predominant source type, accounting for 65.85% of the publications. *Scientific novelty.* The publication structure and temporal development of research at the intersection of distance education and special education have been mapped; the findings indicate that this research has expanded over time and has developed as an interdisciplinary field with strong connections to technology, psychology, and health-related disciplines. *Practical significance.* The results provide a foundation for future citation, keyword co-occurrence, co-authorship, and content analyses and help identify research concentrations, relatively underrepresented areas, and directions for future inquiry.

Keywords: distance education, special education, bibliometric analysis, Scopus, online learning, students with disabilities.

Introduction. Digital technologies have increasingly reshaped educational systems, and online learning has become an established alternative and complement to traditional face-to-face instruction. Distance education offers opportunities for time- and location-independent learning, repeated access to learning materials, self-paced progression, and the use of assistive technologies. When appropriately designed, digital learning environments can improve accessibility and inclusion while supporting

pedagogically effective learning experiences. These considerations are particularly important for students with special educational needs and disabilities.

The online learning experiences of students with special needs are shaped by multiple factors, including the type of disability or impairment, the technologies used, instructional design, students’ self-regulation skills, teacher support, opportunities for interaction, and the accessibility of learning materials. Öhrstedt

et al. (2024), in a study involving 6,256 university students, including 430 students with special needs, showed that online education presents both opportunities and challenges for this population. The ability of technology to compensate for barriers, promote more equitable participation, and provide flexibility in learning constitutes important advantages. However, difficulties related to planning and self-regulation, low motivation, stress, uncertainty surrounding assessment processes, and limited interaction remain important concerns. These findings underscore that students with special needs are a heterogeneous group whose online learning experiences should not be evaluated as uniform.

Similarly, the current literature emphasizes that digital accessibility cannot be reduced to technical standards alone. Lomellini et al. (2025), in a review of 91 sources on accessible and inclusive online higher education, identified barriers encountered in online learning, frameworks for accessible and inclusive instructional design, and institutional responsibility for accessibility as key research areas. Technical features such as alternative text, accurate captions, accessible documents, and compatibility with assistive technologies are important; however, an inclusive online learning experience also requires careful instructional design, meaningful student participation, institutional support, and attention to learner diversity. Accessibility should therefore be treated as a core quality criterion embedded in the design of the learning environment from the outset.

Within this context, Universal Design for Learning (UDL) provides a framework for supporting students with diverse learner profiles. Seymour (2024) found that applying UDL principles in online courses through accessible learning resources, a clear and organized weekly structure, peer interaction, and supportive instructional practices can enhance students' online learning experiences. However, the implementation of UDL does not automatically guarantee an effective or inclusive learning environment. In a systematic review of 32 peer-reviewed studies, Zhang et al. (2024) identified several implementation challenges, including

insufficient reporting of how UDL principles were operationalized, uneven application of UDL components, and limited explanation of the theoretical foundations of interventions. These findings suggest that technology should not be treated as an end in itself; rather, online learning environments should be systematically designed, evidence-informed, and adapted to learners' needs.

The COVID-19 pandemic made these issues even more prominent. The rapid shift from face-to-face instruction to emergency remote teaching made pre-existing challenges related to accessibility, individualized instruction, and support services more visible in digital environments. In a scoping review concerning children with special educational needs and disabilities, Bakaniene et al. (2023) identified substantial parental support needs, disruption of daily routines, inequalities in access to technology and resources, insufficient accommodations, and social isolation as major concerns. Research on distance education has also highlighted the importance of individualized instruction and the difficulties teachers experience in providing appropriate support (Karnas et al., 2023). Similarly, university students with learning disabilities and/or attention-deficit/hyperactivity disorder were reported to experience greater challenges in academic and emotional adjustment during periods of remote learning (Sarid & Lipka, 2023).

Distance education outcomes in special education may also vary according to the type of disability or impairment. Yıldız et al. (2022) found that orthopedic, visual, and hearing impairments were associated with differences in e-learning adoption among university students with disabilities. Large-scale evidence also supports the importance of considering disability type. Koçdar et al. (2025) analyzed learning analytics data from 98,875 learners with special needs in an open education system and reported that academic performance varied by disability category. The study further indicated that overall academic success was positively associated with learning management system use. These findings suggest that digital inclusion requires attention not only to system access but

also to the ways in which learner characteristics influence engagement with and outcomes in online learning environments.

Beyond academic access, digital and assistive technologies may support broader dimensions of student development. Pang and Datu (2025), in a meta-analysis of 26 studies, reported a positive overall effect of digital assistive technology interventions on the well-being of students with disabilities. They also emphasized that the effectiveness of such technologies may vary according to student characteristics and educational context. This evidence suggests that the value of assistive technologies extends beyond access alone and should be considered in relation to students' broader educational and psychosocial experiences.

Another important issue is the relationship between cognitive load and online learning. In a systematic review, Le Cunff et al. (2024) found that cognitive, instructional, and social factors can influence cognitive load in online learning, while research specifically addressing the experiences of neurodiverse students remains limited. This gap indicates a need for more detailed examination of the cognitive demands experienced by neurodiverse learners. Accordingly, accessibility in digital learning environments should be considered alongside variables such as cognitive load, motivation, self-regulation, social interaction, and psychological well-being.

Taken together, these studies show that distance education in special education intersects with pedagogical, technological, psychological, cognitive, and accessibility-related dimensions. On the one hand, online learning can offer flexibility, access to assistive technologies, and learning materials that can be adapted to individual needs. On the other hand, poorly designed digital environments may create or intensify barriers related to accessibility, cognitive load, limited interaction, and self-regulation. This duality suggests that understanding the development of distance education in special education requires not only individual empirical studies but also a systematic examination of the field's overall scientific production.

Bibliometric analysis offers a useful methodological approach for systematically examining the development of a research field over time and describing the structure of its scientific production. Bibliometric performance indicators can be used to analyze publication trends, subject areas, document types, publication languages, countries, institutions, and source types, thereby identifying the disciplines in which research is concentrated, the contributors to scientific output, and the geographical and institutional structure of a field. Current frameworks for bibliometric research also emphasize the distinction between performance analysis and relationship-based science-mapping techniques and recommend selecting analytical methods that are aligned with the research questions and the structure of the available data (Öztürk et al., 2024).

Broader Scopus-based bibliometric studies of digital learning have shown that the Social Sciences are among the dominant subject areas and that the United States is a prominent contributor to scientific publication output (Vaicondam et al., 2022). Bibliometric research focusing on e-learning accessibility for students with disabilities has likewise demonstrated the increasing visibility of educational technology, accessibility, and special-needs themes (Obidat, 2022). However, studies that jointly examine the international Scopus literature using the terms "distance education" and "special education" across publication year, subject area, document type, language, country, institution, and source type appear to be limited. Kim (2025), for example, examined research on distance education for students with disabilities between 2015 and 2024 and found that studies intensified during the pandemic, whereas student-focused and experimental research remained relatively limited.

Therefore, it is important to examine how scientific publications at the intersection of distance education and special education have developed over time, the disciplines in which they are concentrated, the countries and institutions contributing to scientific production, the publication types that predominate, and the scientific communication channels

through which this research is disseminated. Such an assessment can describe the overall structure of the existing literature while also identifying research concentrations, relatively underrepresented areas, and directions for future inquiry. Accordingly, using Scopus data retrieved on September 14, 2026, this study aims to provide a current and holistic overview of the literature on distance education in special education by systematically examining the bibliographic and temporal characteristics of publications meeting the specified search criteria.

Access to quality education for individuals with special needs is a fundamental issue in educational equity and inclusion. The widespread use of digital learning environments offers these students new opportunities, including flexibility in time and place, adaptation to individual learning pace, and access to assistive technologies. However, when accessibility and individualized instruction are not adequately addressed, digital environments may reproduce or intensify existing educational inequalities. Distance education in special education should therefore be evaluated not only in terms of technological infrastructure but also in relation to pedagogical, psychological, social, and accessibility-related dimensions.

This study is significant because it provides a holistic overview of the key publication characteristics of the international Scopus literature on distance education and special education. By examining publication years, subject areas, document types, publication languages, countries, institutions, and source types, the study identifies where scientific production is concentrated and how the current structure of the field has developed. Such an overview is useful for identifying temporal and disciplinary trends and for recognizing areas that remain relatively underrepresented.

Furthermore, this study provides a foundation for more comprehensive bibliometric and content-analytic research. Describing the current publication structure can inform subsequent analyses of keyword co-occurrence, co-authorship, country collaboration, citation patterns, bibliographic coupling, and thematic change. In this respect, the study is expected

not only to characterize the existing literature but also to support the development of a future research agenda on distance education in special education.

The main purpose of this study is to describe the publication landscape of distance education research in special education by examining the basic bibliographic characteristics and temporal development of all Scopus-indexed publications that contain both the terms “distance education” and “special education” and met the specified search criteria as of September 14, 2026. All 123 publications returned by the search were included in the analysis without additional filtering, exclusion, or sampling. The publications were categorized by publication year, subject area, document type, publication language, country, institution, and source type. The study aims to describe the current structure and temporal development of research at the intersection of special education and distance education, identify prominent areas of scientific production, and provide a basis for future research.

Accordingly, the study sought to answer the following research questions: (1) What is the distribution of publications on distance education in special education by year? (2) What is the distribution of publications on distance education in special education by subject area? (3) How are the publications distributed by document type and source type? (4) What is the distribution of publications by language? (5) What is the distribution of publications by country? (6) What is the distribution of publications by institution?

Materials and Methods. This study employed a descriptive bibliometric review design. In bibliometric research, clear reporting of the research question, data source, search strategy, data-cleaning process, and analytical techniques is essential for reproducibility and methodological quality (Öztürk et al., 2024). The present study focused on performance indicators available through Scopus, including publication count, publication year, subject area, document type, publication language, country, institution, and source type. Because the dataset used in this study did not include citation relationships,

co-authorship networks, or keyword co-occurrence matrices, science-mapping analyses were not conducted. The study was therefore limited to descriptive bibliometric performance analysis. This approach is consistent with the performance-analysis logic used in Scopus-based bibliometric studies of disability and e-learning (Obidat, 2022).

The research data were obtained from the Scopus database. The search was conducted on September 14, 2026. In the Scopus interface, the search field was set to “Article Title, Abstract,

Keywords,” and the terms “distance education” and “special education” were entered together. The search yielded 123 documents (Figure 1; Table 1). No restrictions were applied by year, country, publication language, document type, or source type. All 123 publications that met the search criteria and were indexed in Scopus as of September 14, 2026, were included in the study. Therefore, no additional filtering, eligibility screening, or sampling was performed; the analysis covered all records returned by the query.

Figure 1

Scopus Database Search and Number of Records Retrieved (September 14, 2026)

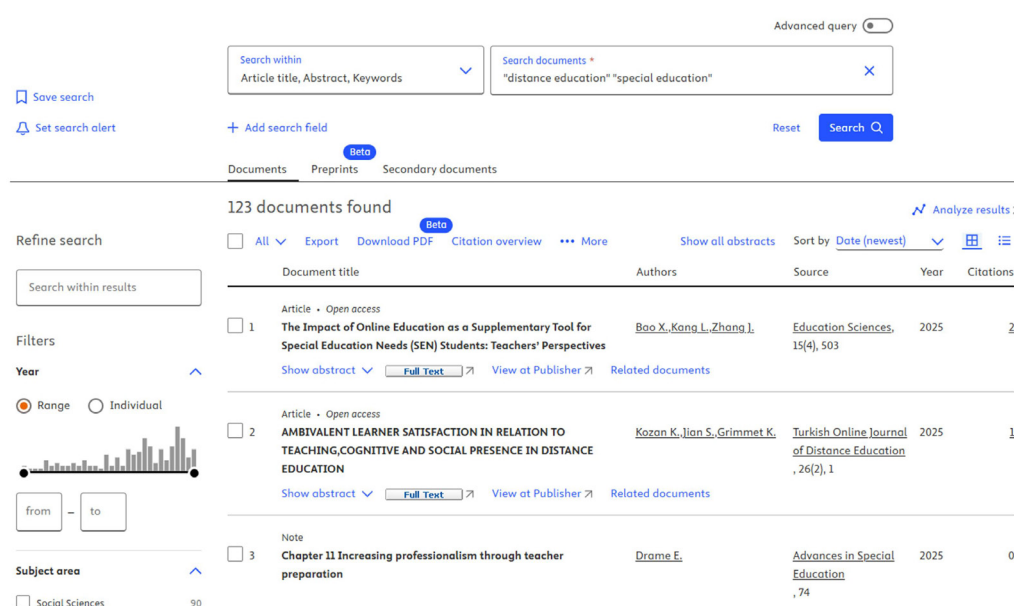


Table 1

Scopus Search Strategy and Dataset Coverage

Component	Explanation
Database	Scopus
Search date	14.09.2026
Search field	Article title, Abstract, Keywords
Search terms	«Distance education» and «special education»
Total records	123 documents; all records included in the analysis
Scope	All Scopus-indexed publications meeting the specified search criteria
Type of analysis	Descriptive bibliometric performance analysis
Variables examined	Publication year, subject area, document type, publication language, country, institution, and source type

Note. The search terms were entered together in the selected Scopus search field. Reporting the exact search terms and field selection supports methodological transparency and reproducibility.

The scope of the study comprises all publications retrieved from Scopus on September 14, 2026, using the terms “distance education” and “special education” in the “Article Title, Abstract, Keywords” field. The 123 publications returned by this search were included in the analysis without further selection or sampling. For each record, the relevant bibliographic metadata used in the analysis were recorded, including publication year, language, country, institution, document type, subject area, and source type. No additional restrictions were applied. The dataset therefore represents all Scopus-indexed publications that met the specified search criteria on the date of the search.

Frequency values were obtained from the Scopus filter screens, and percentages were calculated for each category based on the total number of records ($n = 123$). Publication year, document type, and source type are mutually exclusive categories, so the frequencies within each of these variables sum to 123. In contrast, subject area, publication language, country, and institution may include more than one classification or affiliation for a single record; therefore, total frequencies for these variables

may exceed 123 and the corresponding percentages may exceed 100%. For publication year, each record was assigned to a single year, and annual frequencies and percentages were calculated accordingly.

The study did not collect data from individual participants and relied exclusively on bibliographic metadata from scientific publications. Accordingly, the study involved no intervention with human participants and no analysis of personal data.

Results. The yearly distribution (Table 2) shows that the earliest publication in the dataset dates to 1994 and the most recent publications to 2025. The highest number of publications was recorded in 2022 ($f = 16$; 13.01%), followed by 2016 and 2023 with 11 publications each (8.94%), and by 2017 and 2021 with eight publications each (6.50%). A total of 95 publications (77.24%) were published between 2013 and 2025, compared with 28 publications (22.76%) between 1994 and 2012. This pattern indicates that publication activity at the intersection of distance education and special education became more sustained after 2013, with a notable concentration during 2021–2023.

Table 2

Distribution of Publications by Year

Year	frequency	%
2025	7	5.69
2024	4	3.25
2023	11	8.94
2022	16	13.01
2021	8	6.50
2020	3	2.44
2019	7	5.69
2018	2	1.63
2017	8	6.50
2016	11	8.94
2015	6	4.88
2014	5	4.07
2013	7	5.69
2012	1	0.81
2011	4	3.25
2010	1	0.81
2009	5	4.07

2007	1	0.81
2006	1	0.81
2005	3	2.44
2004	1	0.81
2003	2	1.63
2002	1	0.81
2001	1	0.81
2000	2	1.63
1999	1	0.81
1998	3	2.44
1994	1	0.81

Note. The Scopus year filter displays only years in which at least one publication was indexed; years with no publications are therefore omitted from the table. The total frequency is 123.

Table 3 shows that most publications are classified within the Social Sciences ($f = 90$; 73.17%). Computer Science ranks second ($f = 43$; 34.96%), followed by Psychology ($f = 23$; 18.70%). The representation of Medicine ($f = 12$; 9.76%), Health Professions ($f = 11$; 8.94%), and Engineering ($f = 8$; 6.50%) indicates that research at the intersection of distance education and special education extends beyond educational sciences and is also connected to technological and health-related disciplines.

Table 3

Distribution of Publications by Subject Area

Subject area	frequency	%
Social Sciences	90	73.17
Computer Science	43	34.96
Psychology	23	18.70
Medicine	12	9.76
Health Professions	11	8.94
Engineering	8	6.50
Mathematics	6	4.88
Business, Management and Accounting	4	3.25
Arts and Humanities	3	2.44
Decision Sciences	2	1.63
Neuroscience	1	0.81
Chemistry	1	0.81
Biochemistry, Genetics and Molecular Biology	1	0.81

Note. Because a publication may be classified under more than one Scopus subject area, the sum of the frequencies exceeds 123 and the sum of the percentages exceeds 100%.

As shown in Table 4, research articles constitute 60.98% of the dataset ($f = 75$). Conference papers account for 19.51% ($f = 24$), book chapters for 10.57% ($f = 13$), review articles for 5.69% ($f = 7$), books for 2.44% ($f = 3$), and notes for 0.81% ($f = 1$). The predominance of articles indicates that the field is largely represented through peer-reviewed journal publications, while the substantial share of conference papers suggests that applied and technology-oriented work is also disseminated through conference channels.

Table 4*Distribution of Publications by Document Type*

Document type	frequency	%
Article	75	60.98
Conference paper	24	19.51
Book chapter	13	10.57
Review	7	5.69
Book	3	2.44
Note	1	0.81

English is the dominant publication language in the dataset (Table 5; $f = 115$; 93.50%). Portuguese appears in five records (4.07%) and Spanish in three (2.44%), while Turkish, Korean, and Arabic each appear in one record

(0.81%). This distribution reflects the dominant role of English in international academic communication and suggests that research published in other language contexts may have more limited visibility within Scopus.

Table 5*Distribution of Publications by Language*

Language	frequency	%
English	115	93.50
Portuguese	5	4.07
Spanish	3	2.44
Turkish	1	0.81
Korean	1	0.81
Arabic	1	0.81

Note. The total language frequency is 126 because some Scopus records are tagged with more than one publication language.

The United States has the highest publication count in the dataset (Table 6), with 50 publications (40.65%). Brazil follows with 10 (8.13%), Turkey with eight (6.50%), and Greece with seven (5.69%). Norway and China each have five publications, while Kazakhstan has four. These findings indicate that research output

is internationally distributed across multiple regions, although it is concentrated in several countries. Turkey's third-place position in this dataset indicates relatively high publication visibility at the intersection of special education and distance education.

Table 6*Countries Represented by at Least Three Publications*

Country	frequency	%
United States	50	40.65
Brazil	10	8.13
Turkey	8	6.50
Greece	7	5.69
Norway	5	4.07
China	5	4.07
Kazakhstan	4	3.25

United Kingdom	3	2.44
Switzerland	3	2.44
Portugal	3	2.44
India	3	2.44

Note. The Scopus output includes four records in the “Undefined” category. Thailand, Spain, Saudi Arabia, Poland, Italy, Israel, Chile, Canada, and Australia are each represented by two publications, whereas the United Arab Emirates, Taiwan, South Korea, Palestine, Pakistan, Japan, Indonesia, Hungary, Hong Kong, France, the Czech Republic, and Cyprus are each represented by one publication. Because publications may involve authors from multiple countries, the total country frequency may exceed 123.

West Virginia University has the highest institutional publication count (Table 7), with 10 publications (8.13%). Universitetet i Oslo follows with five publications (4.07%), while the National and Kapodistrian University of Athens and Abai Kazakh National Pedagogical University each have four publications (3.25%). Because most institutions are represented by three or fewer publications, scientific output appears to be distributed across numerous universities and research institutions rather than concentrated in a single institutional center.

Table 7

Institutions Represented by at Least Three Publications

Organisation	frequency	%
West Virginia University	10	8.13
Universitetet i Oslo	5	4.07
National and Kapodistrian University of Athens	4	3.25
Abai Kazakh National Pedagogical University	4	3.25
University of Macedonia	3	2.44
The University of North Carolina at Charlotte	3	2.44
Northern Arizona University	3	2.44
The University of Utah	3	2.44

Note. Institutional frequencies are not mutually exclusive because publications may include multiple authors and institutional affiliations. Many additional institutions appear in the Scopus results with one or two publications.

Regarding source type (Table 8), 65.85% of the publications ($f = 81$) were published in journals. Conference proceedings account for 14.63% ($f = 18$), books for 11.38% ($f = 14$), and book series for 8.13% ($f = 10$). These findings indicate that journals are the primary scientific communication channel for research at the intersection of distance education and special education.

Table 8

Distribution of Publications by Source Type

Source type	frequency	%
Journal	81	65.85
Conference proceeding	18	14.63
Book	14	11.38
Book series	10	8.13

Discussion. The temporal distribution indicates that research on distance education in special education dates back to 1994 and that publication activity has increased over time. Of the 123 publications, 95 (77.24%) were published between 2013 and 2025, suggesting that the topic has developed into a more sustained research area during the past decade. The highest annual output occurred in 2022 ($f = 16$; 13.01%), and 35 publications (28.46%) were published during 2021–2023. This concentration is consistent with the heightened research attention given to distance education and the education of students with special needs during and immediately after the COVID-19 pandemic. Kim (2025) similarly reported that research on distance education for students with disabilities intensified during the pandemic within the 2015–2024 period. Aristovnik et al. (2023) also demonstrated a rapid expansion of online-learning research associated with COVID-19. The 2022 peak in the present dataset, rather than a peak in 2020, may partly reflect the time required to conduct studies, prepare manuscripts, complete publication processes, and achieve Scopus indexing. However, the lower frequencies observed in 2024 and 2025 should not, by themselves, be interpreted as evidence of a lasting decline. Longitudinal monitoring that incorporates keyword, citation, and content indicators would be necessary to evaluate whether the temporal pattern represents a sustained shift.

The classification of 73.17% of the publications in the Social Sciences, 34.96% in Computer Science, and 18.70% in Psychology indicates that distance education research in special education is interdisciplinary, combining educational, technological, and human-behavior perspectives. This finding is consistent with Vaicondam et al. (2022), who identified the Social Sciences as the most prevalent subject area in their analysis of 1,361 Scopus records on digital learning. Similarly, Obidat (2022) demonstrated that educational technology, accessibility, disability, and digital learning are closely interconnected themes within the literature on e-learning accessibility for students with disabilities. Thus, although

the predominance of the Social Sciences is expected, the substantial representation of Computer Science and Psychology suggests that the field also engages with technological design, user experience, cognitive processes, and psychosocial adjustment. The visibility of Psychology is also consistent with recent empirical and review research. Le Cunff et al. (2024), for example, showed that the relationship between neurodiversity and cognitive load in online learning remains insufficiently examined, while Öhrstedt et al. (2024) identified self-regulation, motivation, stress, interaction, flexibility, and assistive technologies as important dimensions of students' online higher education experiences. Together, these studies support the presence of psychology- and health-related perspectives in the current bibliometric distribution and demonstrate that distance education in special education cannot be understood solely in terms of technological access.

The document and source-type findings further clarify the scientific communication structure of the field. Articles are the most common document type (60.98%), conference papers rank second (19.51%), and journals are the dominant source type (65.85%). This pattern indicates that research at the intersection of distance education and special education is disseminated predominantly through peer-reviewed journal channels. The result is comparable with Aristovnik et al. (2023), whose bibliometric analysis of 8,303 Scopus records on online learning found that most research was published in scientific journals. By contrast, Prahani et al. (2022) reported conference proceedings as the most common document type in their study of learning management system research covering 2,689 Scopus records. This difference may reflect variation in disciplinary emphasis: research on learning management systems often focuses on technological infrastructure and software development, whereas research at the intersection of distance education and special education may place greater emphasis on pedagogical, psychological, accessibility, and applied educational issues. Nevertheless, the role of conferences should

not be overlooked. Because distance education, assistive technologies, accessible interfaces, and digital teaching tools are rapidly evolving areas, conferences provide important venues for disseminating emerging technologies and preliminary findings. The predominance of journal publications in the present dataset nevertheless suggests that the field also has a substantial body of peer-reviewed, detailed research reports. This interpretation is consistent with Öztürk et al. (2024), who emphasize that document and source types are important performance indicators for understanding a field's scientific communication structure.

English accounts for 93.50% of the publication-language records, making it one of the most prominent characteristics of the dataset. This proportion is comparable with the findings of Aristovnik et al. (2023), who reported that approximately 95% of the 8,303 Scopus publications examined in the context of online learning and COVID-19 were in English. Prahani et al. (2022) likewise identified English as the dominant publication language in learning management system research. The predominance of English in the present study therefore appears to reflect a broader linguistic pattern in Scopus-indexed digital-learning research rather than a feature unique to the intersection of special education and distance education. Importantly, this finding should not be interpreted as evidence that research in other linguistic or cultural contexts is absent. Scopus coverage and the role of English as a common language of international scholarly communication can increase the visibility of English-language publications. The presence of national-language research, such as the Turkish-language study by Dayı and Basık (2022), further illustrates this point. Future comparisons of Scopus with ERIC, Web of Science, and regional or national databases may clarify the extent to which the observed linguistic distribution reflects database coverage.

The United States has the highest publication count in the country distribution, with 50 publications (40.65%), a pattern that is consistent with previous bibliometric research. Vaicondam et al. (2022) identified the United States as the

leading country in digital-learning research in terms of publication output and citations. Obidat (2022) similarly reported that the United States was the most productive country in the literature on e-learning accessibility for students with disabilities and noted the comparatively strong contribution of developed countries while emphasizing the need for greater international collaboration. The present findings may therefore reflect the substantial research capacity of the United States in special education, educational technology, digital accessibility, and higher education. At the same time, the publication counts for Brazil ($f = 10$), Turkey ($f = 8$), and Greece ($f = 7$) show that research in this area is not confined to North America. Turkey's relatively high representation is also consistent with recent empirical studies conducted in the country. Yıldız et al. (2022) showed that factors influencing e-learning adoption can differ by disability type among university students with disabilities. Dayı and Basık (2022) highlighted access and collaboration needs in the distance education experiences of university students with special needs, while Karnas et al. (2023) documented challenges faced by special education teachers in maintaining individualized instruction and support services during distance education. These studies provide contextual support for Turkey's visibility in the bibliometric results.

At the institutional level, West Virginia University has the highest publication count ($f = 10$; 8.13%), followed by Universitetet i Oslo with five publications and the National and Kapodistrian University of Athens and Abai Kazakh National Pedagogical University with four publications each. This distribution indicates that publication output is not concentrated in a single institutional center. The result differs from Obidat (2022), who identified the University of Washington as the most productive institution in the broader e-learning accessibility literature. This difference is not necessarily contradictory; bibliometric rankings are sensitive to the concepts used in the search, the search strategy, the period covered, and the unit of analysis. In the present dataset, the leading institution accounts for only

8.13% of all publications, and the remaining institutions have even smaller shares, indicating a dispersed pattern of institutional productivity. However, publication counts alone cannot determine whether institutions form strong or weak collaborative networks. Assessing collaboration requires separate analysis of co-authorship relationships and inter-institutional networks. As Öztürk et al. (2024) emphasize, performance analysis should be distinguished from relationship-based science-mapping techniques. Accordingly, the present study describes institutional productivity but does not draw conclusions about the structure or strength of institutional collaboration.

The bibliometric findings also have implications for research and practice. A consistent message across the literature is that technical accessibility alone is insufficient to ensure inclusive and effective distance education for students with special needs. Starks (2022) showed that special education teachers working in K–12 online learning environments require differentiated instruction, flexible content arrangements, and family–school collaboration. Lowenthal and Lomellini (2023) identified gaps in the knowledge and skills of instructors and educational technologists related to designing accessible online courses and materials. Similarly, Lomellini et al. (2025) identified student barriers, accessible course design, universal-design approaches, and institutional responsibility as central themes in the literature on accessible and inclusive online higher education. These studies help explain the simultaneous representation of Social Sciences, Computer Science, Psychology, and health-related fields in the present dataset: inclusive online learning requires the integration of pedagogical design, technical accessibility, and attention to learner characteristics. Differentiation among students with special needs should therefore remain central to the research agenda. Sarid and Lipka (2023) showed that university students with learning disabilities and/or ADHD may experience greater vulnerability in academic and emotional adjustment during remote learning, while Petlik (2024) identified challenges related to emotion

regulation, participation, and perseverance among students with exceptionalities. Polat et al. (2022) also indicated that online education can offer benefits in the context of autism spectrum disorder, although adaptability and usability require further improvement. Future studies that distinguish learners by disability type, educational level, digital skill level, assistive technology use, and instructional model may therefore produce more precise and actionable evidence than studies that treat students with special needs as a homogeneous group.

By examining all 123 Scopus records that met the specified search criteria on September 14, 2026, without additional sampling or exclusion, this study provides a current descriptive overview of publication activity at the direct intersection of the terms “distance education” and “special education.” Kim (2025), focusing on distance education research for students with disabilities between 2015 and 2024, found that research intensified during the pandemic while student-focused and experimental studies remained relatively limited. The present study extends this perspective by providing an international Scopus-based overview across subject area, document type, source type, publication language, country, and institution. It is important, however, to distinguish the present approach from science mapping. This study constitutes descriptive performance analysis rather than a network-based bibliometric analysis. Obidat (2022), by comparison, combined performance analysis with science-mapping techniques to examine collaboration and thematic structure in the e-learning accessibility literature. Öztürk et al. (2024) likewise emphasize that bibliometric techniques should be selected in accordance with the research question and available data structure. The absence of citation networks, co-authorship networks, keyword co-occurrence maps, and bibliographic-coupling analyses in the present study should therefore be understood as a methodological boundary of the selected design. A logical next step would be to export the complete metadata for the 123 records in CSV or BibTeX format and conduct citation, co-authorship, country-collaboration, keyword co-occurrence, and thematic-evolution analyses

using tools such as VOSviewer or Bibliometrix/Biblioshiny.

Conclusions. This study provides a bibliographic and temporal overview of all 123 Scopus-indexed publications that met the specified search criteria at the intersection of the terms “distance education” and “special education” as of September 14, 2026. The publications span 1994–2025, with a clear concentration after 2013 and the highest annual output in 2022 ($f = 16$; 13.01%). The concentration of publications during 2021–2023 indicates increased scholarly attention to distance education in special education during and immediately after the COVID-19 pandemic. The literature is predominantly classified within the Social Sciences, with substantial representation in Computer Science and Psychology. Articles are the most common document type, journals are the dominant source type, and English is the principal publication language. The United States has the highest publication count, followed by Brazil, Turkey, and Greece. Although West Virginia University has the highest institutional publication count, the overall distribution across many institutions indicates that the field is not concentrated within a single institutional center. Considered together with the related literature, the findings show that distance education in special education is an interdisciplinary research area that brings together pedagogical design, digital accessibility, psychosocial adjustment, assistive technologies, and institutional support. Further development of the field would benefit from research addressing accessible digital design, individualized support, teacher and educational-technologist competencies, family–school collaboration, disability-specific instructional strategies, and the direct experiences of students with special needs.

The study has several limitations. First, this study is based exclusively on the Scopus database; publications indexed only in Web of Science, ERIC, Google Scholar, or regional databases were not included. Second, the search was limited to the two exact terms “distance education” and “special education.” Publications using related concepts such

as “online learning,” “e-learning,” “remote learning,” “special educational needs,” “disability,” or “inclusive education” without containing both search terms may therefore have been excluded from the dataset. Third, temporal development was examined descriptively using annual frequencies and percentages. Advanced time-series analysis, thematic-evolution analysis, and period-based citation analysis were not conducted. Fourth, the study focused on descriptive performance indicators; citation analysis, co-authorship-network analysis, keyword co-occurrence analysis, bibliographic coupling, and co-citation analysis were not performed. Fifth, because individual publications may be assigned to more than one category for subject area, publication language, country, and institution, the percentages for these variables are not mutually exclusive and may sum to more than 100%. Finally, Scopus is a dynamic database. New indexing, metadata corrections, and changes in database coverage may cause the same query to return a different number of records at a later date.

Prospects for further research are related to the following directions. First, future studies should expand the search strategy by incorporating synonyms and related concepts and should conduct sensitivity analyses to evaluate the effect of alternative search terms. Second, Scopus records should be exported in CSV or BibTeX format and analyzed using tools such as VOSviewer or Bibliometrix/Biblioshiny to examine keyword co-occurrence, co-authorship, country collaboration, and citation networks. Third, beyond annual publication counts, future research should compare the pre-COVID-19, pandemic, and post-pandemic periods in terms of keywords, citations, and content indicators to examine the conceptual evolution of the field over time. Fourth, the publications should be subjected to content analysis according to disability or impairment type, educational level, instructional model (synchronous, asynchronous, or blended), and the assistive technologies used. Fifth, Scopus and Web of Science results should be compared to evaluate differences in database coverage and indexing patterns. Finally, greater emphasis

should be placed on mixed-methods studies that of students with special needs, their families, jointly examine the online learning experiences and their teachers.

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Sensemaking, Sensegiving, and Rectoral Leadership: Evidence From Kazakhstan

Abstract

Introduction. University autonomy reforms in Kazakhstan have expanded the formal authority of higher education institutions, yet public universities remain shaped by state priorities, funding rules, accountability mechanisms, and performance indicators. This article examines what this tension means for organizational change in a state-steered system with historically centralized administrative traditions: *Methodology and Methods.* Drawing on Kezar's change macro framework, it uses conceptual analysis informed by a multiple-case study of three regional public universities implementing international dual degree programs. *Results.* The article argues that external forces should be treated as a primary domain of change, not merely as contextual background. *Scientific novelty.* It develops a dual sensemaking and sensegiving model of rectoral leadership, showing how university rectors interpret ministerial priorities upward and translate them downward into institutional narratives. Finally, it introduces compliant transformationalism to describe leaders who use the language of transformation while operating within constrained autonomy - *practical significance.* The article contributes to scholarship on higher education change, leadership, and governance.

Keywords: organizational change, sensemaking; sensegiving, rectoral leadership, higher education, university autonomy, dual degree programs.

Introduction. University autonomy has become a central reform idea in Kazakhstan's higher education policy. The 2018 Law on Institutional Self-Governance expanded university authority over academic programs, organizational structures, financial management, staffing, and internal governance (Government of the Republic of Kazakhstan, 2018). Yet formal autonomy has not removed ministerial steering. The Government of the Republic of Kazakhstan (2023) continues to define national priorities, monitor performance, and evaluate institutional progress through policy concepts, state programs, funding mechanisms, and key performance indicators.

This creates a central tension for organizational change. Universities are expected to act as strategic and autonomous institutions, but many major reforms are still defined through national policy. They are encouraged to innovate, yet often within boundaries set

elsewhere. This tension is especially visible in regional public universities, which must respond to demographic, economic, and competitive pressures while also demonstrating alignment with national priorities.

Recent international literature confirms that institutional autonomy is often shaped not only by law, but also by government steering, performance agreements, external evaluation, and centralized accountability systems (Couck, 2026; Kohtamäki & Poutanen, 2025; Lackner, 2024; Yasa & Aksoy, 2025). This is particularly relevant for Kazakhstan, where earlier research has shown that the transition toward institutional autonomy has been accompanied by continued state influence over university behavior (Sagintayeva & Kurakbayev, 2015). In this context, autonomy is not simply a legal category. It is a negotiated governance condition shaped by policy instruments, institutional capacity, and leadership interpretation.

The issue is also linked to internationalization. Kazakhstan has used internationalization as a policy tool for modernization, global alignment, and institutional competitiveness (Akkari et al., 2023). In the post-pandemic context, internationalization policies have become more closely connected to institutional strategy, quality assurance, and global positioning (Gao & Liu, 2023). International dual degree programs are one visible example of this trend. They promise international visibility and curricular modernization, but they also require language capacity, academic coordination, partner management, and institutional readiness.

Kezar's (2018) change macro framework is useful for analyzing this process because it connects the type of change, context, leadership and agency, and change strategies. It also foregrounds culture, shared leadership, sensemaking, and the distinction between incremental and transformational change. However, the framework was developed mainly in Western, particularly United States, higher education contexts, where institutions usually have greater formal autonomy. In state-steered systems such as Kazakhstan, external forces are not simply environmental pressures. They often define what change should be, how it should be reported, and how leadership performance will be judged.

This article adapts Kezar's change macro framework to analyze organizational change in state-steered higher education systems and explains the role of rectoral sensemaking and sensegiving in this process. The article draws on conceptual analysis informed by a qualitative multiple-case study of three regional public universities in Kazakhstan, referred to as Iris, Tulip, and Clover. These universities implemented international dual degree programs as part of a broader national transformation agenda. The cases are used illustratively to refine how organizational change and rectoral leadership are theorized in strongly steered systems.

The article makes three arguments. First, external forces should be treated as a primary domain of change because national legislation, ministerial concepts, supranational reform agendas, performance indicators, and funding

rules shape not only the context of change, but also its content and legitimacy. Second, rectoral leadership in such systems involves dual sensemaking and sensegiving: rectors interpret national priorities upward and translate them downward into institutional narratives (Kezar, 2013; Weick, 1995). Third, the article introduces compliant transformationalism as a leadership pattern in which rectors use transformational language and promote visible reform projects while operating within strong external constraints.

Context of Higher Education Reform in Kazakhstan

Since independence in 1991, Kazakhstan's higher education system has moved through several reform phases, including marketization, Bologna alignment, internationalization, and, more recently, autonomy and transformation. These reforms have changed universities' formal position, but they have not removed the state's central role in shaping institutional priorities.

The 2018 Law on Institutional Self-Governance expanded university authority over academic programs, organizational structures, staffing, and financial management (Government of the Republic of Kazakhstan, 2018). In policy language, universities were expected to become more strategic, entrepreneurial, and accountable. Boards of directors also gained greater prominence in institutional governance. However, autonomy did not mean the withdrawal of ministerial steering. National concepts, state programs, accreditation expectations, funding rules, and performance indicators continued to shape what universities were expected to prioritize (Government of the Republic of Kazakhstan, 2023).

Regional universities experience this tension sharply because they face demographic pressure, uneven research capacity, competition from larger institutions, and expectations to contribute to regional development. They must respond to local needs while also demonstrating international competitiveness and alignment with national reform priorities.

International dual degree programs have become one visible policy instrument within

this environment. They are promoted as tools for internationalization, institutional transformation, and regional university development. For policymakers, they offer a visible sign of modernization and global alignment. For universities, they can create opportunities but also risks. Collaborative and dual degree programs depend not only on external partnerships, but also on the salience of internal university stakeholders and the sustainability of institutional commitment (Shenderova, 2023).

The three universities discussed in this article, Iris, Tulip, and Clover, operate within this policy environment. They differ in size, location, disciplinary profile, and organizational culture. Yet all three are regional public universities facing expectations to demonstrate transformation. All three have used international dual degree programs as part of their institutional strategies. This makes them useful cases for examining how external policy forces interact with rectoral leadership and internal sensemaking.

Literature Review and Conceptual Framework

Kezar's (2018) change macro framework offers a useful lens for analyzing organizational change in higher education because it brings together four areas that are often treated separately: the type of change, the context for change, leadership and agency, and change strategies. Its strength lies in recognizing that university change is not only technical. It is also cultural, political, cognitive, and relational.

The framework distinguishes between first-order and second-order change. This distinction is useful because many reforms look ambitious in policy documents but remain limited in institutional practice. A reform may expand activity without changing the institution's deeper logic. Transformational change requires shifts in values, identities, practices, and culture. In this respect, the framework helps distinguish between visible reform and bigger institutional change.

Kezar also emphasizes context. Universities are shaped by history, governance arrangements, institutional culture, stakeholder expectations, and their relationship with the state and

society. Culture is especially important. Kezar and Eckel's (2002b) work shows that change strategies are more likely to succeed when they connect with institutional values and local meanings. When reforms are perceived as imposed or culturally disconnected, they may produce new documents and structures without changing everyday practice.

Leadership and agency are also central to the framework. Kezar moves beyond heroic models of rectoral leadership and highlights shared leadership, stakeholder engagement, and the social construction of meaning. Rectors matter, but they are not the only actors. Deans, faculty, students, professional staff, and external stakeholders all shape how change is interpreted and enacted. Research on institutional transformation similarly shows that sustainable change depends on sensemaking, interrelated strategies, and balance between external demands and internal culture (Kezar & Eckel, 2002a).

This article extends Kezar's framework through the concepts of sensemaking and sensegiving. Weick's (1995) sensemaking framework is useful because it shows how actors interpret ambiguous situations through identity, experience, social interaction, extracted cues, and plausible narratives. Sensemaking is therefore not a purely individual or technical process. It is social, ongoing, and closely connected to action.

Kezar's (2013) work on sensemaking and sensegiving in higher education is especially important for this article because it shows that change becomes meaningful through social interpretation, not only through formal plans. Recent work on leadership communication during organizational transformation also emphasizes that leadership involves constructing, communicating, and negotiating meaning during institutional change (Frølich et al., 2025). This is directly relevant to rectoral leadership in state-steered systems, where rectors must interpret external priorities and then translate them into institutional language.

Birnbaum's (1992) distinction between instrumental and interpretive leadership is also useful for analyzing rectoral roles in this context.

Instrumental leadership focuses on structures, systems, goals, performance, and compliance. Interpretive leadership focuses on meaning, identity, values, and shared understanding. Rectors in Kazakhstan need both. They must manage indicators, budgets, reporting, staffing, accreditation, and risk. But they must also explain why reforms matter, connect external mandates to institutional purpose, and help stakeholders see change as meaningful rather than merely imposed.

Traditional distinctions between transactional and transformational leadership remain relevant (Bass, 1997; Bass & Avolio, 1994). Transactional leadership focuses on targets, compliance, monitoring, and risk management. Transformational leadership focuses on vision, culture, motivation, and shared purpose. Yet these categories do not fully capture leadership in systems with constrained autonomy. Rectors may use transformational language and pursue visible reform projects, while the direction and pace of change remain closely tied to state-defined priorities. This article calls this pattern compliant transformationalism.

Materials and Methods. This article is conceptually oriented but empirically informed by a qualitative multiple-case study of three regional public universities in Kazakhstan. The cases are anonymized as Iris, Tulip, and Clover. They were selected because each institution implemented international dual-degree programs within the broader national agenda of university transformation and internationalization. The empirical material is used illustratively rather than statistically. The purpose is not to claim that these three cases represent all public universities in Kazakhstan. Rather, the cases ground the conceptual argument and show how the same national policy instrument can take on different meanings across institutions.

The underlying study drew on qualitative data from institutional documents and stakeholder accounts related to the implementation of international dual degree programs. Documents included strategic materials, policy texts, institutional plans, and materials related to program implementation. Stakeholder accounts helped illuminate how leaders, administrators,

and academic actors interpreted reform priorities, institutional risks, and internal capacity. The analysis followed an interpretive logic. It focused on how external policy priorities were translated into institutional narratives, how rectors framed dual degree programs, and how internal stakeholders made sense of these reforms. The cases were compared to identify differences in rectoral framing, institutional capacity, stakeholder engagement, and perceived risk. This approach is consistent with the article's theoretical interest in sensemaking, sensegiving, and organizational change.

Results. *Extending Kezar's Framework for State-Steered Systems*

Kezar's framework remains useful for analyzing change in Kazakhstan. It helps identify the type of change, the importance of culture, the role of leadership, and the strategies used to implement reform. However, it needs extension when applied to systems where the state strongly defines reform priorities. This article proposes three adaptations. First, treat external forces as a primary domain of change. Second, understand rectoral leadership through dual sensemaking and sensegiving. Third, leadership typologies should include compliant transformationalism as a distinct pattern in constrained autonomy settings.

External Forces as a Primary Domain

In Kezar's (2018) original framework, external forces appear mainly as context or as one source of change. This works well in systems where institutions have substantial discretion to respond to their environments. In Kazakhstan, however, external forces often do more than create pressure. They define the reform agenda. National legislation, ministerial concepts, funding priorities, accreditation expectations, and KPIs shape what universities are expected to do and how success is judged. International dual degree programs, for example, have been promoted as national instruments of transformation, internationalization, and regional university development (Akkari et al., 2023; Government of the Republic of Kazakhstan, 2023). For regional universities, this can therefore become a matter of legitimacy, not only academic innovation.

This argument aligns with recent international research showing that government steering, state–institution agreements, and external autonomy evaluations can limit institutional autonomy (Couck, 2026; Kohtamäki & Poutanen, 2025; Lackner, 2024). Comparative research on centralized higher education systems also shows that institutional actors can experience formal autonomy and academic freedom differently, depending on governance arrangements and state control (Yasa & Aksoy, 2025).

External forces interact with all parts of Kezar’s framework. They shape the type of change by defining reform content and pace. They shape context through funding, regulation, and accountability. They shape leadership by narrowing or widening rectors’ room for maneuver. They shape strategy by encouraging visible projects, rapid implementation, formal compliance, or selective adaptation. For this reason, external forces should be placed at the center of the analysis. In state-steered systems, they are not background conditions. They drive organizational change.

Dual Sensemaking and Sensegiving

The second extension is the dual sensemaking and sensegiving model. Kezar’s (2013) framework recognizes sensemaking inside institutions. The proposed adaptation adds the vertical relationship between ministry and university.

The model can be summarized as follows: *Ministry sensemaking → rectoral sensemaking → rectoral sensegiving → institutional sense-making → enactment/adaptation/resistance.*

Ministries construct policy meanings by defining priorities, identifying problems, and selecting reform instruments. Rectors then interpret these instruments through the lens of institutional capacity, political risk, and accountability expectations. They then translate reform into institutional narratives. Faculty, students, deans, and staff interpret these narratives through their own interests and experiences. The reform is then enacted, adapted, resisted, or decoupled. This model shows why leadership matters even in strongly steered systems. Rectors are not fully autonomous actors, but they are not powerless. Their interpretations and narratives shape how external mandates enter institutional life.

Leadership Typology in Constrained Autonomy

The third extension concerns leadership. Transactional leadership focuses on targets, compliance, monitoring, and risk management. It can support delivery, but it may produce broad yet shallow change. Transformational leadership focuses on vision, culture, motivation, and shared purpose. It has greater potential for second-order change, but it requires enough autonomy to reshape institutional direction (Bass, 1997; Bass & Avolio, 1994). Compliant transformationalism sits between these two patterns (Table 1). It combines transformational language with strong alignment to external mandates. Rectors who practice compliant transformationalism speak about transformation, competitiveness, internationalization, and modernization. Yet the content and timing of their reforms closely track national policy priorities.

Table 1

Leadership Typology in Constrained Autonomy

Leadership pattern	Core orientation	Likely change outcome
Transactional leadership	Compliance, KPIs, risk management	Adjustments or broad but shallow change
Transformational leadership	Vision, culture, shared purpose	Potential for deep second-order change
Compliant transformationalism	Transformational rhetoric within external constraints	Mixed change: visible reform, symbolic alignment, selective deeper shifts

Compliant transformationalism captures a real leadership response to a specific governance condition. Rectors must satisfy external expectations while maintaining internal

legitimacy. They must show progress to the state and Board of Directors, while persuading faculty and students that reforms are meaningful. This concept helps explain why reforms in Kazakhstan may look ambitious and constrained at the same time. Institutions may launch international partnerships, revise strategies, and speak the language of transformation. Yet bigger change depends on whether these projects alter academic culture, internal governance, teaching practices, research capacity, and stakeholder trust.

Empirical Illustration: Three Institutional Vignettes

Iris University: Transformation through a Ministerial Project

At Iris University, the international dual degree initiative was closely linked to national reform priorities. It arrived with ministerial attention, external expectations, and strong symbolic value. The newly appointed rector interpreted the initiative as an opportunity to reposition a regional university facing geographical and reputational constraints. This reflects the sensemaking process described by Weick (1995), where leaders construct plausible meanings from external cues and use them to guide action.

The rector framed the dual degree initiative as part of a broader transformation agenda. Strategic documents connected the partnership to curriculum renewal, English-language capacity, assessment practices, infrastructure, and academic culture. The reform was therefore not presented as a narrow program-level arrangement. It was presented as evidence of institutional renewal. This framing aligns with Kezar's (2013) argument that sensegiving helps institutional actors understand change and locate it within a broader organizational narrative.

Iris also shows how external forces shape the type and scope of change. In Kezar's (2018) framework, external pressures form part of the context for change. In this case, however, they did more than create context. They shaped the reform's urgency, legitimacy, and indicators of success. Internally, the reform generated mixed responses. Some actors saw it as a meaningful opportunity to modernize academic practice.

Others viewed it as another top-down project. This confirms Kezar and Eckel's (2002b) argument that change strategies must connect with institutional culture to move beyond formal adoption. Iris therefore illustrates compliant transformationalism. The rector used transformational language and a visible national project to mobilize institutional change. Yet the reform remained closely tied to external indicators, Board of Directors oversight, and ministerial expectations. The case shows both the potential and the fragility of transformation under constrained autonomy.

Tulip University: Co-Oriented Vision and Student-Centred Dialogue

At Tulip University, the dual degree initiative was framed differently. The rector did not treat it mainly as a reputational project. Instead, it was connected to a wider agenda of academic integrity, research development, student engagement, and teaching quality. This reflects an interpretive approach to leadership, where the leader works not only with structures and targets, but also with meaning, values, and institutional identity (Birnbbaum, 1992).

The rector invested heavily in communication. Town halls, open forums, and meetings with students and staff became important sensegiving spaces. The leadership explained why change was needed, invited feedback, and connected internationalization to local concerns. The dual degree initiative was presented as one part of a larger effort to improve academic standards and strengthen the university's culture.

This approach gave the reform stronger internal meaning. It was not only about satisfying a national priority. It also addressed issues that faculty and students recognized in their own environment. By linking internationalization to academic integrity and student experience, the rector made the reform more culturally coherent. This aligns with Kezar and Eckel's (2002b) idea of culturally responsive change, where reform becomes more sustainable when it resonates with local values and practices.

Tulip also reflects the importance of shared vision in organizational change. Doten-Snitker et al. (2021) show that building shared vision can support change by helping stakeholders

understand why the reform matters and how they are connected to it. In Tulip's case, the rector's communicative approach helped position the dual degree initiative as part of a broader institutional conversation rather than as a purely external mandate. At the same time, Tulip remained within the same state-steered policy environment. The rector still had to demonstrate progress, respond to national expectations, and align with transformation discourse. The difference was in the internal translation. Tulip shows that even in constrained autonomy systems, rectors can create more dialogic and locally meaningful approaches to reform.

Clover University: Professional Development amid KPI Anxiety

Clover University faced similar external pressure to implement dual degree programs. However, the leadership interpreted the reform through the lens of institutional capacity and risk. Deans and faculty were anxious about KPIs, deadlines, quality expectations, and the consequences of failure. This illustrates how organizational actors make sense of reform not only through policy language, but also through local histories, available resources, and perceived risks (Weick, 1995). In response, the rector adopted a cautious strategy. Rather than presenting the dual degree initiative as a dramatic transformation, the leadership framed it as gradual capacity building. Professional development became a central sensegiving tool. Training, pedagogical support, staff development, and experimentation helped make the reform feel more manageable.

This approach reflects the distinction between instrumental and interpretive leadership (Birnbaum, 1992). Instrumentally, the rector had to respond to KPIs and external accountability. Interpretively, the rector had to reduce anxiety, build confidence, and give the reform a realistic institutional meaning. The leadership therefore avoided overpromising and focused on credibility, consolidation, and gradual improvement.

Clover also illustrates the difference between visible reform and bigger organizational change. Transformational change requires more than structural adjustment. It requires changes

in beliefs, practices, and institutional culture (Kezar, 2018). Clover's leadership recognized that dual degree programs could not succeed through formal adoption alone. Faculty needed time, support, and professional confidence.

Clover therefore represents a more cautious form of compliant transformationalism. The leadership did not reject the national transformation agenda. It aligned with it but translated it into a slower, more developmental pathway. This reduced the risk of symbolic transformation and showed that cautious leadership can be strategic when institutional capacity is limited.

Together, the three cases show that national policy does not enter universities uniformly. Iris translated the dual degree initiative into a transformation narrative. Tulip connected it to academic culture and student engagement. Clover framed it through capacity building and risk management. These differences confirm the importance of sensemaking and sensegiving in higher education change (Kezar, 2013; Weick, 1995).

Discussion. This article contributes to debates on organizational change in higher education by showing how established change frameworks travel unevenly across governance contexts. Kezar's (2018) change macro framework remains valuable because it brings together context, culture, leadership, agency, and strategy. However, the Kazakhstan cases suggest that the framework needs adjustment when applied to systems where the state remains a powerful architect of institutional change.

The first implication is theoretical. In strongly steered systems, external forces cannot be treated only as part of the environment. They often define the reform itself. National laws, ministerial concepts, Bologna-inspired reform scripts, funding priorities, and KPIs shape what universities are expected to change, how quickly change should happen, and how success will be measured. This builds on earlier work showing that big change depends on interactions among external pressure, institutional culture, leadership, and change strategy (Kezar & Eckel, 2002a).

The Kazakhstan case adds an important qualification to this literature. In state-steered

systems, the interaction between external pressure and institutional response is more vertical. The ministry does not simply apply external pressure. It provides the language, instruments, and legitimacy through which change is understood. This is consistent with research on institutional autonomy and state steering in Kazakhstan and other higher education systems (Couck, 2026; Kohtamäki & Poutanen, 2025; Lackner, 2024; Sagintayeva & Kurakbayev, 2015).

The second implication concerns leadership theory. The cases show that rectoral leadership in Kazakhstan is neither purely transactional nor fully transformational. Rectors must deliver KPIs, manage risk, and comply with external expectations. These are transactional and instrumental tasks. At the same time, they are expected to articulate vision, motivate stakeholders, and present their institutions as transforming. This aligns more closely with transformational and interpretive leadership (Bass, 1997; Bass & Avolio, 1994; Birnbaum, 1992).

The concept of compliant transformationalism captures this hybrid condition. It describes leaders who use transformational language while operating within strong external constraints. This concept avoids two overly simple interpretations. It does not reduce rectors to passive policy implementers. At the same time, it does not romanticize them as fully autonomous change agents. Their leadership is real, but bounded.

This argument also extends research on sensemaking and sensegiving. Weick's (1995) sensemaking theory shows that organizational actors interpret ambiguous conditions and construct plausible meanings for action. Kezar's (2013) work shows that change becomes meaningful through social interpretation, not only through formal plans. Recent research on leadership communication during organizational transformation reinforces this point (Frølich et al., 2025). The present article adds a vertical dimension: rectors in state-steered systems first make sense of ministerial priorities and then engage in sensegiving inside the institution.

The three vignettes show that the same national policy can become different institu-

tional projects depending on rectoral framing, institutional culture, and perceived capacity. This supports Kezar and Eckel's (2002b) argument that change strategies must connect with institutional culture to move beyond formal compliance. It also confirms that collaborative and dual degree programs depend on internal stakeholder engagement, not only external partnership agreements (Shenderova, 2023). For policymakers, the findings suggest that steering mechanisms shape not only institutional behavior, but also institutional meaning. The design of KPIs, funding rules, reporting requirements, and policy concepts affects how rectors interpret reform. If policy instruments are too prescriptive, they may encourage formal adoption without deeper organizational learning. If indicators reward only visible outputs, leaders may prioritize projects that look transformative but do not necessarily change academic culture.

External mandates may produce formal structures that signal legitimacy while leaving core practices relatively unchanged, explaining why some reforms become symbolic or decoupled from everyday academic work (Meyer & Rowan, 1977). A more productive approach would combine steering with structured sensemaking. Ministries could create forums where rectors, boards of directors, and academic leaders discuss how to adapt national priorities to institutional contexts. For leadership development, the study highlights the importance of interpretive capacity. Rectors need technical competence in finance, regulation, governance, and quality assurance, but also the ability to read policy environments, construct credible narratives, and create spaces for shared interpretation (Birnbaum, 1992).

The study also points to the importance of distributed leadership. Change cannot depend only on rectors. Deans, department chairs, program directors, faculty leaders, and professional staff also interpret and translate reform. Otherwise, reforms may remain rectoral projects rather than institutional projects. This is consistent with Kezar's (2018) emphasis on shared leadership and with work showing that organizational change is strengthened when stakeholders participate in constructing

a shared vision (Doten-Snitker et al., 2021). Overall, organizational change in Kazakhstan's higher education system is produced through the interaction of state steering, rectoral interpretation, institutional culture, and local capacity. Kezar's framework helps analyze this process, but it needs adaptation. External forces should be treated as a primary domain. Rectoral leadership should be understood as dual sensemaking and sensegiving. Transformational leadership should be seen as constrained, negotiated, and often compliant rather than fully autonomous.

Conclusion. This article has argued that organizational change in state-steered higher education systems requires closer attention to external policy forces. While Kezar's (2018) change macro framework remains useful for analyzing context, culture, leadership, agency, and strategy, the Kazakhstan cases show that it needs adaptation where the state directly shapes the content, pace, legitimacy, and risks of institutional change. The article makes three

contributions. First, it argues that external forces should be treated as a primary domain of change, as national laws, ministerial concepts, KPI regimes, and funding priorities enter institutional life through strategies, reporting systems, leadership narratives, and performance expectations. Second, it develops a dual sensemaking and sensegiving model of rectoral leadership, showing how rectors interpret ministerial priorities upward and translate them downward into institutional narratives (Kezar, 2013; Weick, 1995). Third, it introduces compliant transformationalism to describe leaders who use the language of transformation while operating within constrained autonomy. The three cases show that the same national policy can take on different institutional meanings. This confirms the importance of sensemaking, institutional culture, and rectoral interpretation in externally steered change. Future research could test the proposed framework through comparative studies of other state-steered higher education systems.

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Teaching Artificial Intelligence in Primary School: An Example-Based Approach Using ML for Kids and Scratch

Abstract

Introduction. The study addresses the challenge of integrating foundational artificial intelligence (AI) and machine learning concepts into primary education to foster early algorithmic thinking and digital literacy: *methodology and Methods.* The study used a mixed-methods design, combining document analysis of the national draft curriculum with an experimental intervention involving 21 second-grade students using ML for Kids and Scratch. Additionally, the study administered a diagnostic survey to 44 in-service Informatics teachers. *Results.* A five-stage integration model was established. Practical acoustic model training improved students' conceptual understanding of machine learning and increased their motivation to learn. Teachers showed strong interest in AI education (88.4%), and demand for specialized training courses was substantial (54.5%). *Scientific novelty.* The study validates a constructivist, block-based instructional pipeline linking supervised machine learning tools with visual block programming tailored to primary school standards - *practical significance.* The proposed framework and instructional scenarios offer direct guidelines for educators and curriculum designers implementing applied AI literacy in primary classrooms.

Keywords: artificial intelligence, primary education, ML for Kids, Scratch, digital literacy, pedagogical model.

Introduction. The rapid and pervasive advancement of digital technologies has fundamentally transformed societal structures, communication paradigms, and educational systems worldwide (Holmes & Tuomi, 2022). Among emerging computational breakthroughs, artificial intelligence (AI) has emerged as one of the most transformative catalysts reshaping modern education (Zawacki-Richter et al., 2019; Marr, 2022). As global economies shift toward data-driven, automated ecosystems, technological competence is no longer confined to traditional computer operation; it now demands early foundational literacy in intelligent systems (Chiu & Chai, 2020). Consequently, introducing artificial intelligence into school curricula has shifted from experimental pedagogical enrichment to an indispensable national strategic priority across

many educational jurisdictions (Touretzky et al., 2019; UNESCO, 2022).

Integrating foundational AI and machine learning concepts at the primary school level represents a strategic intervention to prepare future-ready learners (Dai et al., 2020). Early educational stages offer a prime cognitive window for demystifying how automated systems perceive data, make inferences, and influence daily interactions (Kim et al., 2021). However, a persistent pedagogical tension exists in early computing education: early-grade learners possess developing abstract thinking capacities and cannot engage with complex, syntax-heavy text-based programming languages (Tedre et al., 2021). To bridge the gap between traditional introductory computing practices and modern machine learning concepts, educational systems must leverage

visual, block-based programming environments and intuitive machine learning interfaces (Lane, 2021; Resnick et al., 2009).

Despite the growing global interest and high-level curriculum declarations, substantial pedagogical, infrastructural, and methodological challenges remain in primary AI implementation. In many emerging curricula, including the updated national standard framework for “Digital Literacy and Artificial Intelligence” in Kazakhstan (talqylau.bms.kz), clear instructional pipelines that connect supervised machine learning directly to accessible visual coding tools remain underdeveloped (Ministry of Education of the Republic of Kazakhstan, 2023). Successful implementation also requires rigorous assessment of in-service teacher readiness, infrastructural availability, and classroom-tested scaffolding strategies (Celik, 2023; Wang et al., 2023).

To address this gap, this paper investigates the practical integration of AI literacy in early primary classrooms. Specifically, this study aims to determine how artificial intelligence content can be systematically integrated into the primary school “Digital Literacy” curriculum through an applied visual programming approach using Machine Learning for Kids (ML for Kids) and Scratch 3.0. To achieve this objective, the study evaluates the updated national standard curriculum, diagnoses in-service teacher competence and infrastructural readiness, and empirically tests a classroom-level acoustic classification model with second-grade learners to formulate a structured five-stage pedagogical framework. Primary education represents a critical phase in a child’s cognitive, social, and communicative development (Piaget, 1952; Braun, 2016; Vygotsky, 1978). During these formative years, children acquire fundamental cognitive schemata, critical thinking capabilities, and early algorithmic reasoning (Kim et al., 2021; Liu et al., 2023). From a constructionist pedagogical perspective (Papert, 1980), learners internalize abstract concepts most effectively when they actively design, build, and manipulate tangible or visual artifacts.

Introducing AI literacy within this framework allows young children to explore computational

ideas beyond passive digital consumption (Ali et al., 2019; Druga & Ko, 2021). Early exposure to interactive computational models fosters curiosity, algorithmic problem-solving, and adaptive thinking-core competencies required in the 21st-century digital landscape (Kong et al., 2023; Su & Yang, 2022). Constructionist AI activities enable students to construct personal meaning through hands-on model exploration, grounding complex computational processes in concrete, experiential learning tasks (Druga & Ko, 2021; Lane, 2021). Educational researchers broadly agree that teaching AI in early childhood and primary schooling does not entail training children to become professional computer scientists or advanced code writers (Wong et al., 2020). Instead, foundational AI literacy focuses on building conceptual understanding of intelligent systems, human-computer interaction, and the societal implications of technology (Long & Magerko, 2020; Ng et al., 2021; Fridin, 2014). As Touretzky et al. (2019) conceptualize, K–12 AI education encompasses core Big Ideas: perception, representation and reasoning, learning from data, natural interaction, and societal impact. In primary education, this translates into distinguishing between rule-based, deterministic algorithms (conventional coding) and probabilistic, data-driven learning models (machine learning) (Tedre et al., 2021). By engaging with pattern recognition, data collection, and classification algorithms, students learn how machines process inputs and generalize predictive outputs (Lin et al., 2021; Su & Zhong, 2022).

To make abstract machine learning paradigms developmentally appropriate for young children (aged 7–8), visual block-based platforms are widely recognized as the standard instructional tool (Resnick et al., 2009). Tools such as ML for Kids coupled with Scratch 3.0 eliminate syntactical cognitive load, allowing learners to focus on the logical pipeline of supervised learning: gathering training data, training a model in the cloud, and programming sprites based on model predictions (Dai et al., 2020; Lane, 2021).

Empirical studies demonstrate that linking machine learning classifiers to visual outputs

(such as voice-controlled or gesture-controlled interactive characters) promotes learner engagement and computational thinking (Chiu et al., 2023; Druga & Ko, 2021). However, instructional transitions between stochastic model outputs and deterministic programming blocks often present cognitive friction, requiring explicit teacher scaffolding and structured instructional scaffolds (Tedre et al., 2021). Comprehensive AI literacy extends beyond technical model building to encompass critical reflections on data ethics, privacy, and algorithmic fairness (Crawford & Paglen, 2021; Holmes et al., 2019). Young learners must be equipped to evaluate how data is collected critically, question algorithmic decision-making, and understand digital safety considerations (Kong et al., 2023; Smakman et al., 2021; UNESCO, 2022).

Nevertheless, the classroom implementation of these concepts depends heavily on teacher competence, self-efficacy, and institutional infrastructure (Celik, 2023; Fan & Zhong, 2022). International studies highlight that while educators exhibit strong positive attitudes toward AI adoption, many feel underprepared in pedagogical content knowledge regarding machine learning and neural networks (Fan & Zhong, 2022; Wang et al., 2023). Addressing these instructional and infrastructural gaps through systematic teacher training and validated pedagogical models remains a vital prerequisite for successful AI integration in primary education (Chiu & Chai, 2020; Han et al., 2021).

Materials and Methods. This investigation used an explanatory sequential mixed-methods design, combining qualitative curricular analysis and experiential pedagogical intervention with a quantitative cross-sectional diagnostic survey (Creswell & Creswell, 2018). The qualitative strand evaluated the national standard curriculum and described classroom implementation of artificial intelligence (AI) literacy through block-based machine learning environments. The quantitative strand evaluated the technological readiness, competence profiles, infrastructural constraints, and professional development demands of in-service informatics educators. Participants

The empirical component involved two targeted participant groups: Primary School Students: A cohort of $N = 21$ second-grade students (aged 7–8 years) participated in the laboratory-based teaching experiment focusing on voice recognition model construction and visual programming. In-Service Educators: A total of $N = 44$ primary and secondary school educators teaching Informatics and Digital Literacy completed the structured survey. Within this cohort, 37.2% possessed 1–5 years of pedagogical experience, 32.6% had more than 10 years of teaching tenure, and 53.5% taught at the secondary level. Furthermore, 45.5% reported prior practical experience teaching AI-related modules.

A structured analytical matrix was applied to the draft standard curriculum for “Digital Literacy and Artificial Intelligence” (Grades 1–4), accessible on the national Center for Curriculum Analysis discussion platform (talqylau.bmsokz). The protocol systematically assessed thematic organization, grade progression, continuity of learning objectives, and depth of AI concepts - teacher Competence and Readiness Questionnaire: A multi-dimensional diagnostic survey utilizing 5-point Likert scales and structured category items. The instrument evaluated five core areas: theoretical understanding of AI concepts (machine learning, neural networks), practical application in everyday contexts, methodological capability to teach children, material and technical school infrastructure, and qualification upgrade demands. The questionnaire showed high internal reliability (Cronbach’s $\alpha = 0.86$). Standardized observational sheets and post-intervention reflective dialogues captured student motivation, algorithmic conceptualization, and technical hurdles during block-based model assembly. The research was conducted through four structured operational phases:

Phase 1: Curricular Document Analysis. Systematic qualitative content analysis of state curriculum documents, confirming the integration of the dedicated section “Media Literacy and Artificial Intelligence” into primary school standards.

Phase 2: Teacher Survey Administration. Electronic dissemination of the diagnostic instrument to active Informatics educators, yielding 44 fully validated responses.

Phase 3: Machine Learning Model Training (ML for Kids). In the classroom laboratory setting, second-grade students executed a hands-on “Voice Control” project. Within the ML for Kids environment, students initiated a “Sound Project” and generated discrete categorical labels: “background noise”, “Salem”, “jump” (sekir), “dance” (bile), and “run” (jygir). Each student provided 8 audio samples per class to build the training dataset. The system executed cloud-based supervised training (Learn & Test), and students verified real-time classification accuracy.

Phase 4: Block-Based Programming and Integration (Scratch). Students imported the verified machine learning model into Scratch 3.0 via custom extension blocks. Students constructed visual scripts linking recognized speech inputs to interactive sprite behaviors (e.g., triggering the Cat sprite’s dialogue “Oh, Salem!”, jumping across coordinate axes, or executing rhythmic dancing routines).

Ethical Consideration. The study followed the ethical principles of the Declaration of Helsinki and the Law of the Republic of Kazakhstan “On Personal Data and Their Protection” (No. 94-V of 21 May 2013). The intervention was conducted during regular scheduled lessons using publicly available educational software and did not involve collecting personal or sensitive data; therefore, it did not require formal ethics committee review under the applicable institutional regulations. The school administration granted permission, and parents or legal guardians were informed about the study and consented to their children’s participation. Teachers’ participation in the survey was voluntary and anonymous. All audio samples contained only short command words without identifying information and were deleted after the sessions; all data are reported in anonymized and aggregated form.

Results. Pedagogical Framework for AI Integration in Primary Education. Synthesizing the qualitative curriculum document analysis

with the classroom experimental outcomes resulted in a validated five-stage pedagogical model for introducing machine learning into primary curricula. The conceptual stage introduces fundamental concepts and distinguishes between deterministic, rule-based algorithms and statistical learning models through accessible real-life analogies. In the data collection stage, students gather, categorize, and label training data using acoustic samples. During the model training stage, learners construct and train a classification model within the ML for Kids environment. The application and programming stage enables students to visualize model inference by integrating trained blocks into Scratch 3.0 to animate sprite behaviors. Finally, the reflection and ethics stage supports structured, teacher-guided discussions on model accuracy, digital data privacy, and the ethical dimensions of automated systems.

Classroom Implementation and Student Outcomes. The experimental intervention conducted with second-grade students ($N = 21$) demonstrated high engagement and measurable conceptual acquisition. Hands-on acoustic data collection and immediate visual verification in Scratch significantly increased students’ motivation to learn, with reflective feedback highlighting positive experiences such as excitement when the computer recognized speech and animated the sprite. Students successfully grasped the fundamental four-step machine learning principle: the user speaks, the computer listens, the model learns, and the character executes the command. However, several learners encountered operational obstacles when linking model prediction blocks to conditional loops in Scratch, confirming the necessity of structured pedagogical scaffolding during visual coding activities.

Teacher Readiness, Competence Distribution, and Technical Infrastructure. The diagnostic survey conducted among in-service Informatics teachers ($N = 44$) established clear competence distributions across key theoretical, practical, and infrastructural dimensions:

- professional profile and experience: among the respondents, 37.2% possessed 1–5 years of teaching experience, 32.6% had more than 10

years of pedagogical practice, and 53.5% taught at the secondary level. Additionally, 45.5% reported prior practical experience delivering AI-related instructional units, whereas 40.9% had not previously covered these topics;

- theoretical knowledge: teachers' understanding of fundamental AI concepts such as machine learning and neural networks was rated as moderate by 55.8%, fully prepared by 27.9%, and not prepared by 16.3%. When explaining the distinction between deterministic algorithmic solutions and AI models, 54.5% rated their preparedness as moderate, 22.7% as fully prepared, and 22.7% as not prepared;

- practical and methodological competence: a total of 47.7% of teachers reported being fully prepared to provide real-life examples of AI, 43.2% rated their knowledge as moderate, and only 9.1% felt unprepared. In applying generative AI platforms such as ChatGPT, 54.5% reported being fully prepared and 45.5% indicated a moderate level. Respondents rated their readiness to explain complex topics and organize practical AI tasks as moderate, at 54.5% and 52.3%, respectively. In the domain

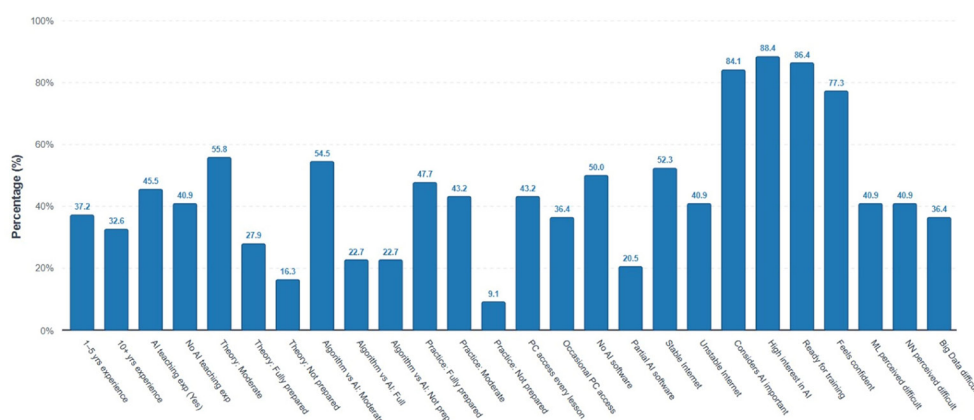
of ethics and safety, 45.5% felt fully prepared and 45.5% reported moderate readiness;

- technical infrastructure: while 43.2% of schools provided computer access in every lesson, 36.4% provided only occasional access. In 50.0% of schools, specialized software for AI instruction was absent, and in 20.5% it was only partially available. Internet connectivity was stable in 52.3% of institutions, with 40.9% reporting periodic instability;

- motivation and professional development demands: teachers expressed strong professional motivation, with 84.1% recognizing AI as essential for students, 88.4% displaying high instructional interest, and 86.4% stating readiness to improve their qualifications. Educators identified machine learning (40.9%), neural networks (40.9%), and big data (36.4%) as the most challenging topics. To address these gaps, educators prioritized professional development courses (54.5%), ready-made instructional materials (43.2%), and improved school hardware equipment (43.2%), favoring offline workshops (34.1%) and structured online courses (31.8%) (Figure 1).

Figure 1

Percentage distribution of teacher competencies, technical infrastructure, and professional development needs



As shown in Figure 1, teachers' professional development needs focus on both competency building and practical implementation support. Professional development courses emerged as the most frequently selected form of support, indicating educators' preference for systematic training to strengthen their AI-related knowledge and teaching skills. At the same

time, the relatively high demand for ready-made instructional materials and improved school hardware suggests that teachers perceive successful AI integration not only as a matter of individual competence but also as dependent on adequate methodological and technological resources. Regarding training formats, respondents preferred offline workshops and

structured online courses, reflecting the need for both hands-on interaction and flexible, organized learning opportunities. Overall, the results indicate that teachers are highly motivated to integrate AI into education but require targeted professional development, practical teaching resources, and appropriate infrastructure to translate this motivation into classroom practice.

Discussion. The empirical outcomes of this study show that integrating artificial intelligence (AI) elements into primary education offers transformative pedagogical opportunities while also introducing specific operational and ethical challenges (Chiu & Chai, 2020). When evaluating instructional benefits, educators identified the development of higher-order cognitive and algorithmic thinking skills (36.4%) and the facilitation of personalized learning pathways (25.0%) as the most significant advantages of early AI literacy. These findings corroborate previous research by Dai et al. (2020), which emphasized that visual block-based machine learning platforms scaffold computational logic while reinforcing learner autonomy.

Conversely, educators expressed valid concerns regarding potential systemic vulnerabilities associated with early technology exposure (Smakman et al., 2021). Teachers' primary risk was increased children's cognitive dependence on automated technologies (36.4%), mirroring earlier concerns raised by Luckin et al. (2016) about passive reliance on technology. In addition, digital data security (25.0%) and preserving academic integrity (25.0%) emerged as key concerns. These findings reinforce international recommendations that primary AI curricula must incorporate data ethics, model transparency, and child-safe data management practices from the outset (Crawford & Paglen, 2021; UNESCO, 2022). Qualitative student feedback and observational data from the ML for Kids and Scratch interventions provide strong empirical support for constructivist learning models in AI education (Druga & Ko, 2021; Papert, 1980). Young learners demonstrated notable motivation when training acoustic recognition models with their own voices and observing interactive sprite responses in real

time. This experiential approach demystified complex computational principles, enabling primary students to grasp the conceptual mechanics of supervised learning without encountering syntactical barriers (Ali et al., 2019; Kong et al., 2023).

However, the transition from model training in ML for Kids to visual programming in Scratch revealed cognitive friction for a subset of students. Linking probabilistic model predictions with deterministic conditional structures in Scratch required explicit teacher-led scaffolding. As Tedre et al. (2021) note, teaching machine learning requires distinct pedagogical strategies from conventional programming, necessitating structured templates and scaffolded visual tasks for early primary learners. To support effective curricular integration, survey respondents emphasized the need to expand hands-on practical exercises (42.9%) and implement specialized teacher professional development programs (38.1%). Given that over half of teachers demonstrated moderate theoretical understanding of machine learning and neural networks (55.8% and 54.5%, respectively), ongoing professional development programs focused on applied AI pedagogy are critical (Celik, 2023; Fan & Zhong, 2022). Furthermore, technical infrastructure requires targeted institutional upgrades to resolve current deficits, such as the complete absence of specialized AI software in 50.0% of schools and periodic internet instability in 40.9% of classrooms (Wang et al., 2023).

Conclusion. Integrating artificial intelligence (AI) elements into the primary school "Digital Literacy" curriculum is an essential strategic step toward modernizing early technological education and equipping young learners with foundational 21st-century competencies (Ministry of Education of the Republic of Kazakhstan, 2023). By combining the Machine Learning for Kids (ML for Kids) platform with the Scratch 3.0 visual programming environment, primary school students navigate the entire machine learning lifecycle—from acoustic data gathering and supervised model training to block-based code execution and socio-ethical reflection. The empirical outcomes confirm that

introducing early machine learning through a five-stage pedagogical framework fosters foundational algorithmic literacy, demystifies data processes, and enhances creative problem-solving without imposing syntactical cognitive overload. While primary teachers demonstrate positive professional attitudes toward AI adoption, successful national scaling requires targeted professional development programs, ready-to-use pedagogical resources, and improved computing infrastructure across primary classrooms. Future research should focus

on longitudinal assessments of AI literacy retention among early learners, the development of standardized computational assessment metrics, and cross-regional comparative analyses accounting for linguistic and cultural variations in technology-enhanced primary classrooms.

Conflict of Interest. The authors declare no conflict of interest regarding the publication of this manuscript. No financial, personal, or professional relationships have influenced the research design, data collection, analysis, interpretation, or writing of this paper.

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Family Emotional Interaction and Children's Behavioral Types

Abstract

Introduction. This study examines family emotional interaction, which is a key environmental factor in children's socio-emotional development and behavioral adjustment: *methodology and Methods.* Using stratified random sampling, we selected 600 valid samples of Chinese children aged 6-15 and their parents. We collected data using the Strengths and Difficulties Questionnaire and behavioral indicators grounded in developmental research on social withdrawal, attachment, and emotion socialization. We used correlation analysis and multiple regression models to test the hypotheses. **Results.** Positive family emotional interaction predicts children's prosocial behavior and significantly and negatively predicts aggressive and withdrawn behavior; negative emotional interaction shows the opposite pattern and is significantly more strongly associated with aggressive than withdrawn behavior. Similarly, positive emotional engagement predicts prosocial behavior significantly better than it predicts aggressive and withdrawn behavior. The interaction between gender and emotional engagement in the family is not significant, indicating that gender does not significantly moderate the relationship between emotional engagement in the family and children's behavioral outcomes. **Scientific novelty.** Emotional engagement in the family shows differentiated, directional, and strong effects on children's prosocial, aggressive, and withdrawn behavior, with no significant gender effect. These results emphasize that promoting adaptive social development should prioritize the quality of the family emotional environment and emotion socialization processes over gender differences in children - *practical significance.* These results can inform family counseling and parent education.

Keywords: interaction, positive, prosocial, emotional, aggressive, isolating, behavior, impact.

Introduction. Children's prosocial, aggressive, and withdrawn behaviors are core indicators of their social adaptation (Goodman, 2001; Rubin & Chronis-Tuscano, 2021). An imbalance in these behaviors can lead to peer rejection and maladaptive developmental outcomes (Booth-LaForce & Groh, 2018). As children's earliest emotional learning environment, the family plays a foundational role through emotional interaction patterns and emotion socialization processes (Breux et al., 2022; Eisenberg, Spinrad, & Knafo-Noam, 2015). Existing studies have confirmed associations between family emotional interactions and children's social behaviors (Taylor et al., 2013; Wang et al., 2022). However, most studies focus on single behavioral outcomes

rather than comparing prosocial, aggressive, and withdrawn behaviors simultaneously. Therefore, this study focuses on differential impacts to provide empirical evidence for precise family education guidance.

The core objective of this study revolves around "differentiation" and includes three specific aspects:

1. Clarify the "directional differences" (positive/negative predictions) of positive/negative family emotional interactions on children's prosocial, aggressive, and withdrawn behaviors.
2. Conduct a comparative analysis of the "intensity differences" in the impact of family emotional interactions on the three types of behaviors (e.g., whether the predictive coefficient of negative interactions on aggressive behavior

is significantly higher than that on withdrawn behavior).

3. Explore the “moderating differences” of demographic variables such as children’s gender and age on the above impacts (e.g., whether boys are more influenced by family emotional interactions than girls).

Based on the core concept of “differential impacts”, the following hypotheses are proposed:

Hypothesis 1 (Directional Differences): Positive family emotional interactions positively predict prosocial behavior and negatively predict aggressive and withdrawn behaviors; negative family emotional interactions negatively predict prosocial behavior and positively predict aggressive and withdrawn behaviors.

Hypothesis 2 (Intensity Differences): The positive predictive effect of negative family

emotional interactions on aggressive behavior is significantly stronger than on withdrawn behavior. The positive predictive effect of positive family emotional interactions on prosocial behavior is significantly stronger than its negative predictive effect on aggressive/withdrawn behaviors.

Hypothesis 3 (Moderating Differences): Gender moderates the relationship between family emotional interactions and children’s behaviors.

Materials and Methods. This study used a cross-sectional design and recruited Chinese children aged 6-15 years (kindergarten to middle school) and their parents as participants. We distributed 610 questionnaires through stratified random sampling and collected 600 valid questionnaires. Table 1 shows the specific sample characteristics.

Table 1

Sample Characteristics

Variable	Category	n	%
Gender	Boy	333	55.5
	Girl	267	44.5
Age Group	6 years (Kindergarten)	87	14.5
	7–9 years (Primary)	174	29
	10–12 years (Primary)	155	25.83
	13–15 years (Junior Middle)	184	30.67
	Two-parent family	371	61.83
Family Structure	Single-parent family	149	24.84
	Other	80	13.33

In addition, this study’s sampling framework is similar to the author’s previous research; however, the research questions are different. Unlike previous research, which focused on the mediating role of parent-child attachment and the structural mechanisms of emotional interaction on children’s social behavior, this study adopts a new perspective by examining the differential impact of family emotional interaction on various types of children’s behavior (prosocial, aggressive, and withdrawn). This aspect was not covered in the author’s previous research.

Data Collection. Family Emotional Interaction Scale

Based on Eisenberg’s “Emotion Socialization Framework” (Eisenberg, Spinrad, & Eggum, 2010) and “Family Emotional Interaction Theory”. The “Parent Emotional Socialization” section of the questionnaire, consisting of 6 items (questions 6–11), was used to measure family emotional interaction. The scale was culturally adapted to Chinese families and reflects the core processes through which parents guide children’s emotional understanding and regulation (Kochanska & An, 2024).

The scale includes two dimensions:

- positive emotional interaction dimension (5 items): measures positive emotional expression and supportive responses among family mem-

bers, such as “When my child experiences negative emotions, I first listen to the reasons and then guide them to regulate their emotions”. “When my child makes progress, I promptly provide encouragement or praise.”

- negative emotional interaction dimension (1 item, reverse-scored): Measures parents’ negative responses during children’s emotional outbursts, such as “When my child loses control of their emotions, I tend to deny or blame them immediately”.

A 5-point Likert scale (1 = completely disagree, 5 = completely agree) was used for scoring. The total score for the 5 items in the positive dimension indicates the level of positive interaction, with higher scores representing higher levels of positive interaction. For the negative dimension, after reverse-scoring the item, higher scores indicate a more significant degree of negative emotional interaction.

In this study, Cronbach’s α was .83 for the positive dimension and 0.81 for the negative dimension, indicating good reliability.

Children’s Prosocial Behavior Scale. This study used the “Prosocial Behavior” subscale from the parent version of the SDQ (Strengths and Difficulties Questionnaire; Goodman, 2001), which consists of 5 items (questionnaire items 18–22). The subscale includes five items assessing empathy, cooperation, sharing, and helping behaviors, e.g., “Enjoys sharing with other children.”

Scoring follows the original SDQ 3-point scale (0 = not true, 1 = somewhat true, 2 = certainly true), with higher total scores across the 5 items indicating more frequent prosocial behavior.

In this study, the Cronbach’s α coefficient for this subscale was .79, indicating good reliability.

Children’s Aggressive Behavior Scale. This study constructed an aggressive behavior index based on items related to aggressive behavior in the SDQ, including aspects such as emotional impulsivity, aggression, physical aggression, and conduct aggression, with a total of 5 items:

For example, “often loses temper or is easily angered”, “often argues or fights with other children”, “frequency of physical conflicts

(only appears when the previous question is rated as 1 or 2)”, “often lies or cheats”, and “has taken things that do not belong to them”. The SDQ items were scored on a 0–2 scale, with higher total scores indicating more pronounced aggressive behavior.

The Cronbach’s α coefficient for the scale in this study was .82.

Children’s Withdrawal Behavior Scale. This study selected 5 items from the “Emotional Symptoms” and “Peer Problems” subscales of the SDQ, which involve typical items related to social withdrawal, shyness, and withdrawn behavior, to construct the children’s withdrawal behavior index:

For example, “easily nervous or clingy in new environments”, “has many fears, easily scared”, “prefers to be alone”, “(reverse-scored) has at least one good friend”, and “(reverse-scored) is usually liked by other children”. We used the original SDQ scoring system of 0–2, and reverse-scored items were adjusted accordingly. Higher total scores indicate more pronounced withdrawal behavior.

The Cronbach’s α coefficient for the withdrawal behavior scale in this study was .77.

Quality Control. During the data processing, incomplete or abnormal questionnaires were excluded, resulting in a final valid sample of 600 participants.

Ethical Consideration. The study followed the ethical principles of the Declaration of Helsinki and relevant national regulations on research involving human participants. The research used an anonymous, non-interventional parent-report survey that involved no clinical, medical, or experimental procedures and collected no personally identifiable information; under the institutional regulations in force, studies of this type do not require review by a formal ethics committee. We nevertheless observed all ethical safeguards described below throughout the study.

Analysis Methods. Data processing was conducted using SPSS 27.0 software, with the core analysis steps focusing on “differences”:

1. Descriptive Statistics: Calculated the means and standard deviations of family emotional interactions (positive/negative) and the

three types of children's behaviors to observe distribution characteristics preliminarily.

2. Correlation Analysis: Examined the relationships between positive/negative emotional interactions and the three types of behaviors to provide preliminary evidence of directional differences in influence.

3. Multiple Regression Analysis: Tested differences in three steps:

- used the three types of behaviors as dependent variables and positive/negative emotional interactions as independent variables, controlling for gender and age, and conducted regression analysis to compare differences in predictive coefficients (β values) (intensity differences);

- verified the significance of coefficient differences through the "standardized coefficient difference test" (Z-test);

- added the "emotional interaction $\times$ gender" interaction term to test for moderation differences.

Group Analysis: Divided the sample into a boys' group ($n=333$) and a girls' group ($n=267$)

by gender and ran separate regression analyses to visually present moderation differences.

Results. Table 2 presents descriptive statistics for the core variables. The average score for positive emotional interactions within families was 18.56 ($SD = 4.13$), which was significantly higher than the score for negative emotional interactions, 2.32 ($SD = 1.12$). This indicates that the overall emotional interaction atmosphere in the sample families was relatively positive. Children's prosocial behavior scores were relatively high ($M = 11.81$, $SD = 2.20$), while aggression behavior scores were relatively low ($M = 10.74$, $SD = 2.09$), and withdrawal behavior was moderately low ($M = 4.26$, $SD = 2.07$). Overall, the descriptive statistics indicate relatively adaptive social behavior patterns within the sample.

Because the aggression behavior scale included logical skip items (e.g., the frequency of physical conflict items was presented only under certain response conditions), the valid sample size for this variable was 336, while the valid sample size for the other variables was 600.

Table 2

Descriptive Statistics of Core Variables ($N=600$)

	N	Min	Max	Mean	SD
Pos_Int	600	5.00	25.00	18.5617	4.12892
Neg_Int	600	1.00	5.00	2.3150	1.12304
Prosocial	600	5.00	15.00	11.8117	2.19641
Aggressive	336	7.00	16.00	10.7381	2.09260
Withdrawn	600	1.00	10.00	4.2583	2.06528

Table 3 shows the correlation matrix between family emotional interactions and three types of children's social behaviors. The results validate the preliminary hypothesis of "directional differences":

- positive emotional interaction is significantly positively correlated with prosocial behavior ($r = .748$, $p < .01$) and significantly negatively correlated with aggressive behavior ($r = -.566$, $p < .01$) and withdrawal behavior ($r = -.718$, $p < .01$);

- negative emotional interaction is significantly negatively correlated with prosocial behavior ($r = -.597$, $p < .01$) and significantly positively correlated with aggressive behavior

($r = .547$, $p < .01$) and withdrawal behavior ($r = .630$, $p < .01$).

Comparison of absolute values of correlation coefficients: The positive correlation between negative emotional interaction and withdrawal behavior ($|r| = .630$) and the negative correlation between positive emotional interaction and withdrawal behavior ($|r| = .718$) both reach high levels, indicating that family emotional interaction has significant predictive significance for children's internalizing and externalizing behaviors. Overall, the results support the theoretical hypotheses of "directional differences" and "intensity differences."

Because behavior has logically skipped items, its correlation coefficients are based on an effective sample size of 336; the remaining variables are based on a full sample size of 600.

Table 3

Correlation Matrix of Family Emotional Interaction and Children's Behavior (N=600)

	Pos_Int	Neg_Int	Prosocial	Aggressive	Withdrawn
Pos_Int	1	-.570**	.748**	-.566**	-.718**
Neg_Int	-.570**	1	-.597**	.547**	.630**
Prosocial	.748**	-.597**	1	-.547**	-.687**
Aggressive	-.566**	.547**	-.547**	1	.604**
Withdrawn	-.718**	.630**	-.687**	.604**	1

***. p < .01 Level (two-tailed), significant correlation.*

Aggressive behavior involves logical leaps, so its correlation coefficient is based on N = 336, while other variables are based on N = 600.

Multiple Regression Analysis (Differences in Direction and Strength)

After controlling for children's gender (male = 1, female = 0) and age, a multiple regression analysis was conducted using positive family emotional interaction (Pos_Int) and negative emotional interaction (Neg_Int) as predictor variables, and children's three types of behaviors (Prosocial, Aggressive, Withdrawn) as dependent variables. The results, shown in Table 4, further support the "direction difference" and "strength difference."

1) The predictive direction of positive emotional interaction is entirely consistent:

It significantly positively predicts prosocial behavior ($\beta = 0.606$, $t = 19.233$, $p < .001$), significantly negatively predicts aggressive behavior ($\beta = -0.359$, $t = -5.914$, $p < .001$), and significantly negatively predicts withdrawn behavior ($\beta = -0.533$, $t = -16.592$, $p < .001$). This indicates that more positive family emotional interactions are associated with more prosocial behaviors and less aggressive and withdrawn behavior.

2) The predictive direction of negative emotional interaction is also entirely consistent:

It significantly negatively predicts prosocial behavior ($\beta = -0.251$, $t = -7.989$, $p < .001$),

significantly positively predicts aggressive behavior ($\beta = 0.291$, $t = 4.777$, $p < .001$), and significantly positively predicts withdrawn behavior ($\beta = 0.327$, $t = 10.191$, $p < .001$). This indicates that the more negative family emotional interactions there are, the fewer prosocial behaviors children exhibit, and the more aggressive and withdrawn behaviors they display.

The hypothesis of direction difference (H_1) is fully supported.

To compare the predictive strength of different paths, Z-tests were conducted to compare the differences in standardized regression coefficients (see the right column of Table 4):

- the predictive coefficient of negative emotional interaction on aggressive behavior ($\beta = .291$) is significantly greater than that on withdrawn behavior ($\beta = .327$), $Z = 2.02^*$, $p < .05$.

- the predictive coefficient of positive emotional interaction on prosocial behavior ($\beta = .606$) is significantly greater than that on aggressive behavior ($\beta = -.359$) and withdrawn behavior ($\beta = -.533$), with Z values of 2.41^* and 2.19^* , respectively. The hypothesis of strength difference (H_2) is supported.

Table 4

Multiple Regression Analysis of Family Emotional Interaction Predicting Children's Behavioral Outcomes

Dependent Variable	Predictor	β	t	p	R ²	ΔR^2	Z-test for Coefficient Differences
Prosocial	Child gender	.001	-.044	.965	.604	.601**	Pos_Int → Prosocial vs. Pos_Int → Aggressive: Z = 2.41*
	Child age	.027	1.057	.291			Pos_Int → Prosocial vs. Pos_Int → Withdrawn: Z = 2.19*
	Pos_Int	.606	19.233	<.001			
	Neg_Int	-.251	-7.989	<.001			
Aggressive	Child gender	.162	1.401	.162	.370	.362**	Neg_Int → Aggressive vs. Neg_Int → Withdrawn: Z = 2.02*
	Child age	.016	.367	.714			
	Pos_Int	-.359	-5.914	<.001			
	Neg_Int	.291	4.777	<.001			
Withdrawn	Child gender	-.026	-.972	.331	.589	.586**	-
	Child age	.009	.347	.729			
	Pos_Int	-.533	-16.592	<.001			
	Neg_Int	.327	10.191	<.001			

** $p < .01$ * $p < .05$; R² represents total variance explained; ΔR^2 represents the increase in explained variance after entry of the predictors. Aggressive behavior was assessed with a reduced sample size (N = 336) due to a skip-logic mechanism, whereas all other models used the full sample (N = 600).

This study, through regression analysis of three behavioral models, found that:

1) Positive emotional interaction exhibits a directional influence pattern of “promoting prosocial behavior and inhibiting negative behavior”;

2) Negative emotional interaction exhibits a directional influence pattern of “reducing prosocial behavior and increasing negative behavior”;

3) There are significant differences in predictive strength among different pathways, with positive interaction having the strongest prediction for prosocial behavior, and negative interaction predicting aggressive behavior more strongly than withdrawal behavior.

The “directional differences” and “intensity differences” of this study are fully supported.

Moderation Effect Analysis (Gender Moderation Differences)

To examine the moderating role of gender in the relationship between family emotional interaction and children's behavior, this study, controlling for children's gender and age, added interaction terms “positive emotional interaction $\times$ gender” and “negative emotional interaction $\times$ gender” to construct three sets of regression models, with prosocial behavior, aggressive behavior, and withdrawal behavior as dependent variables. Table 5 presents the regression results.

Table 5

Moderation Effects of Gender on the Associations Between Emotional Interaction and Children's Behavioral Outcomes (N=600)

Predictor	Prosocial Behavior					Aggressive Behavior					Withdrawn Behavior				
	β	t	p	R ²	ΔR^2	β	t	p	R ²	ΔR^2	β	t	p	R ²	ΔR^2
Step 1				.589	-				.370	-				.589	-

Gender	-.001	-.044	.965		.062	1.401	.162		-.026	-.972	.331
Age	.027	1.057	.291		.016	.367	.714		.009	.347	.729
Pos_Int	.606	19.233	<.001		-.359	-5.914	<.001		-.533	-16.592	<.001
Neg_Int	-.251	-7.989	<.001		.291	4.777	<.001		.327	10.191	<.001
Step 2				.590	.002			.373	.003		
PosInt_Gender	-.255	-1.744	.082		.235	1.049	.295		.228	1.520	.129
NegInt_Gender	-.275	-3.497	.001		.107	.281	.779		.079	.975	.330

The results show:

1) In the prosocial behavior model, the interaction effect of “positive emotional interaction $\times$ gender” is not significant ($\beta = 0.06$, $p = .278$), indicating that the influence of positive emotional interaction on prosocial behavior does not differ significantly between boys and girls.

2) In the aggressive behavior model, both “negative emotional interaction $\times$ gender” ($\beta = -0.06$, $p = .207$) and “positive emotional interaction $\times$ gender” ($\beta = 0.01$, $p = .881$) are not significant, suggesting that neither negative nor positive emotional interaction has a significant differential impact on aggressive behavior between boys and girls.

3) In the withdrawal behavior model, neither interaction term is significant (p -values $> .05$), similarly showing no gender differences.

In summary, this study found no significant gender moderation effects, and Hypothesis 3 is not supported. In other words, the influence of family emotional interaction on children’s social behavior is consistent between boys and girls.

Discussion. Interpretation of Results: Core Findings Focused on “Differences” - differences in Direction of Influence: The “Opposing Effects” of Two Types of Emotional Interactions.

This study confirmed Hypothesis 1: Positive and negative family emotional interactions have “opposite directional” effects on children’s behavior. Positive interactions promote prosocial behavior through “emotional nourishment” (e.g., parental encouragement makes children more willing to share) and reduce aggressive/withdrawn behavior through “emotional

modeling” (e.g., parents calmly handling conflicts teach children non-violent problem-solving) (Frogley et al., 2023; Nigmatullina et al., 2026; Oh et al., 2021). Negative interactions, on the other hand, increase aggressive behavior through “conflict imitation” (e.g., family quarrels lead children to believe that “aggression is a way to solve problems”) and reduce prosocial behavior while increasing withdrawn behavior through «emotional deprivation» (e.g., parents dismissing children’s emotions make them afraid to socialize proactively) (Hernández et al., 2022; Nivison et al., 2025). These findings are consistent with emotion socialization frameworks suggesting that parental emotional responses shape children’s behavioral adjustment trajectories (Eisenberg, Spinrad, & Eggum, 2010; Laifer et al., 2025).

Differences in Strength of Influence: The “Aggression Specificity” of Negative Interactions and the “Prosocial Specificity” of Positive Interactions.

This study supports Hypothesis 2: Negative emotional interactions have a significantly stronger impact on aggressive behavior than on withdrawn behavior. This may be because aggressive behavior is more “learned”-conflicts within the family (e.g., parental physical punishment or verbal aggression) directly serve as “models” for children’s aggressive behavior. In contrast, withdrawn behavior is more influenced by a “lack of emotional security” (e.g., parental indifference). This pathway also aligns with findings that children’s behavioral problems are indirectly shaped through parental emotion regulation processes (Crespo et al., 2017), and this influence is less “immediate” than the imitation learning of aggressive behavior.

This interpretation aligns with attachment-based perspectives emphasizing the role of emotional security in peer competence and social adjustment (Deneault et al., 2021). Meanwhile, positive emotional interactions have a stronger impact on prosocial behavior because prosocial behavior requires positive reinforcement (e.g., parental praise or cooperative interactions), whereas reducing aggressive and withdrawn behavior is more about negative inhibition (Carreras et al., 2023).

Differences in Moderation: Gender Moderation Effects Did Not Reach Statistical Significance. Hypothesis 3 proposed that gender would moderate the relationship between family emotional interactions and children's social behavior. However, regression results from the study sample showed that neither the interaction term "positive emotional interaction $\times$ gender" nor "negative emotional interaction $\times$ gender" reached statistical significance. This suggests that emotional interaction pathways may operate similarly across boys and girls in this sample. Previous studies have also reported mixed findings regarding gender differences in socialization processes and behavioral outcomes, indicating that contextual and relational factors may play a stronger role than gender alone (Kokkinos et al., 2019).

Although the hypothesis was not supported, this result is valuable for research and may be attributed to the following reasons:

1) Wide age range of the sample: Gender differences may exhibit non-linear patterns across different age groups.

The age range of 6–15 spans kindergarten through middle school, when developmental stages influence aggressive/withdrawn/prosocial behaviors. Gender differences may vary across age groups, and combined analysis may reduce statistical significance.

2) Weakening of traditional gender socialization in Chinese families:

In recent years, most urban families have adopted more consistent emotional education approaches for boys and girls, reducing the impact of gender differences.

3) Behavioral measurements based on parental reports:

Parents may tend to score based on "social expectations", compressing gender behavior differences in the data (e.g., "girls should be well-behaved", "boys being mischievous is normal").

4) Actual effects exist but are small:

Although the interaction terms were positive, the t-values did not reach significance, suggesting that gender moderation effects may exist but are weak and require larger samples or multi-source data for validation.

Therefore, although gender moderation effects were not significant, this result suggests that future research should further focus on:

- the developmental trajectory of gender differences across different age groups;
- the differentiated impact of parenting styles on children of different genders;
- using multi-source data (e.g., teachers, peers, behavioral observations) to reduce single-source bias.

Theoretical Significance

This study is the first to systematically verify the "three-dimensional differences" (direction, intensity, moderation) of family emotional interactions on children's prosocial, aggressive, and withdrawn behaviors. It addresses the limitations of previous studies that focused on "single behaviors" or "general interactions", enriching the theoretical framework of "family-child behavioral" development.

The study introduces the concepts of "negative interaction-aggression specificity" and "positive interaction-prosocial specificity." The results show that negative emotional interactions have the strongest predictive power for aggressive behavior, while positive emotional interactions are most predictive of prosocial behavior. This provides an analytical framework for "behavior-interaction matching" in future research (e.g., focusing on negative interactions when studying aggressive behavior and positive interactions when studying prosocial behavior), making theoretical discussions more precise (Groh et al., 2014).

Practical Significance

1. Provides a basis for "targeted intervention" in parental emotional interaction behaviors.

Research indicates:

- reducing aggressive behavior requires prioritizing the reduction of negative interactions within the family, whereas enhancing prosocial behavior relies more on positive emotional modeling and reinforcement mechanisms;

- the importance of the broader family emotional climate further aligns with the emotion socialization framework proposed by Morris et al. (2007). Thus, a «Family Emotional Interaction Guidebook» can be developed to help parents choose the most effective interaction methods based on their children's behavior types.

2. Offers “differentiated guidance strategies” for school-family collaboration by schools and teachers.

When organizing parent workshops, schools can clarify how different family emotional interactions affect various child behaviors. For example:

- for families of children with high levels of aggressive behavior, focus on training in “conflict management” and “emotion de-escalation techniques”;

- for families of children with weak prosocial behavior, focus on training in “positive reinforcement” and “cooperative communication skills”.

This approach can enhance the effectiveness of school-family collaborative interventions.

3. Provides “targeted support” for special families.

For families prone to emotional interaction imbalances, such as single-parent or grandparent-led households, offer “emotional management courses” (e.g., how to respond calmly to children's emotions) to reduce the negative impact of negative interactions on children's behavior.

Research Limitations

1. Causal relationship limitations: The cross-sectional design cannot clarify the causal direction of “family emotional interaction → child behavior”, and the possibility of “child behavior influencing family emotional interaction” (e.g., children with more aggressive behavior eliciting more negative interactions from parents) cannot be ruled out. Future research should adopt longitudinal designs (e.g.,

annual measurements over three consecutive years) to verify causal pathways.

2. Measurement method limitations: All variables were parent-reported, which may involve “social desirability bias” (e.g., parents overestimating positive interactions and underestimating aggressive behavior). Future studies could incorporate teacher evaluations (e.g., teacher-completed aggression behavior scales), child self-reports, and observational methods (e.g., recording parent-child interaction videos) to improve measurement validity.

Sample representativeness limitations: The sample consisted of 86% two-parent families, which is higher than the national average, and did not include rural areas. Use caution when generalizing the results to non-two-parent families or rural children. Future research should expand the sample scope to include more families from disadvantaged groups.

Future Research Directions

1. Expanding Mediating Variables: To clarify intermediate pathways through which family emotional interactions influence children's behavior, as suggested by research on parental risk contexts and emotion socialization processes (Shadur & Hussong, 2020).

2. Refining Family Types: Compare the differences in the impact of emotional interactions on children's behavior across various family structures (e.g., two-parent, single-parent, and blended families) to provide more targeted intervention programs for special family types.

3. Developing Intervention Programs: Based on the findings of this study, develop a “family emotional interaction training program” and test its effectiveness in improving children's behavior through randomized controlled trials (RCTs) (e.g., whether children's aggressive behavior significantly decreases after parents in the intervention group receive training).

4. Cross-Cultural Comparisons: Compare the differences in the impact of family emotional interaction patterns on children's behavior between Chinese and Western families (e.g., Western families emphasizing “freedom of emotional expression” versus Chinese families emphasizing “emotional restraint”) to enrich cross-cultural research on child development.

Conclusion. Through empirical analysis of 600 Chinese children and their parents, this study draws the following core conclusions regarding “differential impacts”:

1. Directional Differences (Hypothesis 1 Supported): Positive family emotional interactions positively predict children’s prosocial behavior and significantly negatively predict aggressive and withdrawn behaviors; negative family emotional interactions significantly negatively predict prosocial behavior and significantly positively predict aggressive and withdrawn behaviors.

2. Intensity Differences (Hypothesis 2 Supported): The predictive effect of negative family emotional interactions on aggressive behavior is significantly stronger than its predictive effect on withdrawn behavior; the predictive effect of positive family emotional interactions on prosocial behavior is stronger than its negative predictive effect on aggressive/withdrawn behaviors.

3. Moderating Effect (Hypothesis 3 Not Significantly Supported): The moderating effect of gender did not reach statistical significance. In other words, the predictive effects of positive and negative family emotional interactions on the three types of children’s behaviors do not differ significantly between boys and girls.

Although the trends align with theoretical expectations, they did not meet the significance threshold ($p > .05$), and thus no conclusion of “significant moderation” can be drawn.

The research results indicate that family emotional interactions have significant differential impacts on children’s prosocial, aggressive, and withdrawn behaviors, with clear directional and intensity differences. Although gender shows some differences in trends, the moderating effect was not significant, suggesting that the influence of positive and negative emotional interactions on children’s behavior is generally consistent across genders. Therefore, enhancing positive family emotional interactions and reducing negative emotional interactions remain key pathways to promoting the healthy development of children’s social behaviors.

This study has been approved by the Ethics Committee of Al-Farabi Kazakh National University (Approval Number: IRB-A1726) and strictly adheres to the principles of “dual informed consent” (voluntary participation by both guardians and children) and “complete anonymity” (no collection of names, student IDs, or other identifying information). The de-identified data will be used solely for academic research purposes.

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Traditional Textbook or AI Tools: Factors in Students' Choice of Educational Tool in Learning Chinese as a Foreign Language

Abstract

Introduction. The article examines the role of generative AI tools in teaching students studying Chinese as a foreign language. The study aims to identify the factors that determine students' choice between a traditional textbook and AI tools when learning Chinese: *methodology and Methods.* A pilot closed-ended survey of students (n=26) was conducted regarding their preferred means of studying Chinese as a foreign language. *Results.* AI tools are preferred by 50.0% of respondents; another 26.9% use them alongside a textbook; only 7.7% chose the textbook alone. AI is most in demand for conversational practice (73.1%) and checking assignments (61.5%), and least in demand for explaining grammar (23.1%); no respondent completely rejected AI. The factors determining choice were identified as speed of obtaining an answer (57.1%) and constant availability (21.4%); content- and methodology-related factors together accounted for 14.3%. *Scientific novelty.* The study identified the factors that shape students' choice between a traditional textbook and generative AI tools when learning Chinese as a foreign language. *Practical significance.* The results show which types of learning activities students use generative AI tools for most, making it possible to distribute functions more reasonably between the traditional textbook and AI when organizing instruction.

Keywords: learning tools, traditional textbook, artificial intelligence, Chinese language.

Introduction. In recent decades, Chinese as a foreign language (CFL) has become one of the most dynamically developing segments of the global language education market. By the end of 2021, the number of people studying Chinese as a second language exceeded 25 million worldwide. The CFL market itself demonstrates steady growth: according to estimates by the analytical platform HolonIQ, its volume amounts to 7.4 billion US dollars, with a projected annual growth rate reaching 12.1%, and by 2027 the market could reach 13.1 billion dollars. The dynamics of the language's popularity in digital educational environments are also indicative: according to Duolingo, Chinese rose from 9th to 8th place among the most studied languages in the world in 2024 (Gong & Lai, 2024). This strong interest in

CFL stems from a combination of economic, political, and cultural factors tied to China's growing role in global affairs. At the same time, Chinese is rightfully considered one of the most difficult languages for native speakers of European languages to acquire, which poses challenges for CFL teaching methodology.

The linguodidactic complexity of CFL stems from several systemic characteristics that fundamentally distinguish it from alphabetic languages. Learners of Chinese face specific difficulties: mastering the tonal system and the complexity of morphology and writing. From a cognitive psychology perspective, the most significant difficulty is the time and effort required to master characters: the cognitive load from their visual complexity and the need to memorize them is considerable and often

overwhelms beginners. Experimental data confirm that cognitive load impairs sensitivity to tonal distinctions and disrupts the categorical perception of Mandarin tones (Sweller, 2020). Thus, in CFL, the learner is forced to simultaneously master three interconnected yet fundamentally different systems: the phonological system (4 tones plus a neutral tone), the graphic system (characters numbering in the thousands), and the grammatical system (analytic structure, the specifics of measure words, and aspect-tense markers). This multi-level load requires specialized methodological tools to distribute and structure it.

Historically, the printed textbook has served as the instrument of CFL instruction, setting the course's content, methodological, and structural framework. Textbook studies as a scientific discipline has developed criteria for evaluating foreign language textbooks; however, applying these criteria to CFL textbooks remains insufficiently studied. In parallel, over the past decade, a fundamentally different methodological pole has emerged: AI tools and adaptive digital platforms. Generative AI tools, particularly ChatGPT, attract attention for their potential to support language production, provide immediate feedback, and foster learner autonomy. At the same time, the integration of AI into foreign language teaching is actively developing in the EFL context, whereas, with respect to CFL, this field remains at an early stage. Thus, each of these learning tools possesses complementary advantages and limitations: the textbook ensures systematicity but is inferior in adaptability; AI tools offer personalization and instant feedback, yet what guides students in choosing between them remains empirically unstudied, which defines the research question: what factors determine students' choice between a traditional textbook and artificial intelligence tools when learning Chinese as a foreign language?

The textbook has historically occupied a central place in foreign language teaching, providing students with authentic language materials and serving as an essential point of reference for novice teachers (Sheldon, 1988; Ahour et al., 2014). Recognizing this central

role, researchers have formed an independent scientific discipline - textbook studies - within which systematic criteria for the evaluation and selection of teaching materials are developed. Cunningsworth (1995) laid the methodological foundation of this tradition by proposing a three-level evaluation model: pre-use, in-use, and post-use. Most established checklists examine similar parameters - objectives, structure, methodology, organization of material, as well as the manner of presenting language skills and functions depending on the sociocultural context (Cunningsworth, 1995; Ur, 1996; Harmer, 1991). A systematic review of research on ELT textbook evaluation for 2014–2023 showed that questionnaires, surveys, and checklists remain the most widespread instruments in this field, and textbook evaluation itself is recognized as a key mechanism for confirming whether materials meet the needs of students, teachers, administrators, and program developers (Li, 2025).

However, the established tradition of evaluation has a major limitation: most criteria and checklists have been developed based on English-language textbooks (Shak et al., 2022; Li et al., 2025). For Chinese, researchers note that existing instruments do not account for the specifics of the CFL context and require fundamental revision (Dassanayake, 2023). The gap between the methodological development of textbook studies in ELT and its limitations in CFL creates a demand for alternative approaches to supporting instruction, including digital and AI-based ones.

Awareness of the limitations of the traditional textbook has stimulated the search for technological alternatives, leading to the formation of the computer-assisted language learning (CALL) paradigm. Since the earliest CALL practices, AI systems such as intelligent tutoring systems (ITS), natural language processing (NLP), automated language assessment, speech and pronunciation recognition systems, and language learning analytics have significantly influenced foreign language teaching. The transition to intelligent CALL systems (ICALL) marked a qualitative shift: ICALL integrates NLP technologies and

AI modeling methods, creating a new branch that has achieved significant results in second language acquisition and foreign language teaching.

At the level of adaptive platforms, the capabilities of AI turn out to be fundamentally different from those of the printed textbook: AI provides personalized learning, adaptive feedback, and intelligent analysis of student performance, and the integration of CALL and AIALL positively affects student motivation and fosters engagement and active participation in learning activities. A systematic review of empirical studies from the past decade confirms that AI technologies show promise in improving writing quality, assessment accuracy, and student engagement, and the transition from CALL to ICALL has fundamentally changed how students interact with learning content through the integration of big data analytics and machine learning (Alhusaiyan, 2025). Thus, while the traditional textbook ensures systematicity, methodological consistency, and cultural context, AI tools offer what the textbook structurally lacks: immediate feedback, adaptation to individual pace, and the possibility of unlimited practice. Both instruments have proven pedagogical potential, yet their comparative effectiveness for specific languages and skills remains open, and especially so in the context of Chinese as a foreign language.

Chinese as a foreign language represents a unique context in which both approaches under consideration - the textbook-studies approach and the technological approach - face particular challenges stemming from the typological specificity of the language. A bibliometric analysis of research on technology integration in CFL for 2000-2024 shows steady growth in publications yet reveals substantial unevenness: most works focus on individual platforms or tools, while systematic comparative studies remain extremely scarce (Xu, 2024). Regarding AI tools in relation to CFL, the picture is even more telling: AI integration is actively developing in the EFL context, whereas for Chinese as a foreign language it lags considerably behind, and the 2024 International Conference

on Technology and Chinese Language Teaching identified AI tools and digital platforms as priority yet still insufficiently researched areas (Jiang et al., 2024).

Existing studies on AI in CFL are predominantly qualitative or descriptive and focus on individual skills; studies examining lived experience of using AI in authentic communicative tasks within the CFL context are far fewer (Chen et al., 2025). In parallel, a systematic analysis of 43 empirical studies on generative AI in language education for 2022–2024 showed that the overwhelming majority of works focus on English language teaching, while other languages, including Chinese, remain at the periphery of scholarly attention (Wang, 2025).

Textbook studies show a similar pattern: the international literature offers few evaluations of CFL textbooks using scientific criteria, and it largely lacks comparisons between traditional teaching materials and AI tools. Thus, at the intersection of the two gaps identified - the insufficient study of AI in CFL and the absence of textbook-studies research on CFL - a clear research gap emerges, which this study aims to address.

Materials and Methods. Research Design. The study used a quantitative, descriptive design and incorporated elements of a pilot study. Its purpose was to identify the factors determining students' choice between a traditional textbook and artificial intelligence tools when learning Chinese as a foreign language. The study used a cross-sectional design and involved a single data collection. The pilot format served two purposes: testing the developed instrument and obtaining preliminary empirical data to inform a full-scale study.

Participants. Twenty-six students took part in the pilot survey. Participants were selected purposively, in accordance with the following inclusion criteria: (a) enrolment in the first or second year of a bachelor's degree program; (b) study of Chinese as a foreign language at a beginner level corresponding to HSK levels 1–2; and (c) experience of using at least one AI tool for educational purposes. The third criterion was verified through a filter question

at the beginning of the questionnaire, since the absence of such experience would make choosing between the textbook and an AI tool irrelevant for the respondent.

Beginner-level students were targeted deliberately. At this stage of learning, basic learning strategies are forming, and both dependence on structured learning material and the need for prompt support are most clearly expressed, making the choice between tools particularly indicative.

Instrument. Data were collected using a structured, anonymous questionnaire with closed-ended items. The questionnaire comprised three substantive items and a block of demographic characteristics (year of study, language proficiency level according to the HSK scale, and experience of using AI tools).

The instrument's logic reflected the structure of the research question. The first item recorded the general preference for a learning tool. The second differentiated the use of AI tools across aspects of Chinese language learning - grammar, characters, the tonal system, and conversational practice. The third identified the dominant factor of choice, operationalizing six hypothesized grounds: speed of obtaining information, personalization of explanation, trust in the accuracy of the material, systematicity of presentation, institutional requirements, and availability of the tool.

Data Analysis. Given the pilot scope of the study, the analysis was limited to descriptive statistics: absolute frequencies and percentage distributions were computed for each item. Inferential testing was not performed. The sample of 26 respondents was considered sufficient for the pilot stage-testing the clarity of the wording, the discriminative capacity of the response options, and identifying preliminary trends—but does not imply statistical generalization of the results.

Ethical Consideration. The study followed the ethical principles of the Declaration of Helsinki and relevant national regulations on research involving human participants. The research was limited to an anonymous, non-interventional questionnaire survey of adult university students; it involved no medical,

clinical, or experimental procedures, no deception, no sensitive personal information, and no collection of personal identifiable data. Under current institutional regulations, studies of this type do not require review by a formal ethics committee. All ethical safeguards described below were observed throughout the study.

Participation was entirely voluntary. Before starting the questionnaire, respondents received information about the study's aims, the survey's anonymous nature, the approximate time required to complete it, and the intended use of the data for research purposes only. Respondents gave their informed consent by confirming their agreement to participate before proceeding to the substantive questions. Participants were informed that they could withdraw at any point without giving reasons, and that participation, refusal, or withdrawal would have no effect whatsoever on their academic assessment or their relationship with the teaching staff. No incentives or rewards were offered. All participants were of legal age.

The questionnaire contained no names, student identification numbers, contact details, or any other identifiers. Only aggregated demographic characteristics were recorded (year of study, HSK proficiency level, and prior experience of using AI tools), which do not permit the identification of individual respondents. We did not retrieve data from students' personal accounts in AI tools, and we did not collect chat logs, prompts, or interaction histories. The completed responses were stored on a password-protected device accessible only to the research team and are reported exclusively in aggregated form. Given the small pilot sample, we took particular care to present the results in a way that precludes identifying individual participants.

The study's limitations stem from its pilot nature. The small sample size and purposive sampling preclude extrapolating the results to the general student population. The findings provide a basis for refining the instrument and planning a subsequent study with an expanded sample, including the possible inclusion of qualitative methods.

Results. The distribution of responses to the question about the preferred tool for learning Chinese (Table 1) reflects a pronounced orientation of beginner-level students toward generative AI tools. Half of respondents (13 people; 50.0%) turn to AI tools (ChatGPT, Claude, DeepSeek, etc.) for homework, unclear material, and class preparation. 7 respondents (26.9%) use textbook and AI tools equally. In total, more than three-quarters of the sample (76.9%) regularly rely on generative AI in their learning practice. Only 2 respondents (7.7%) chose the traditional textbook as their main tool, while 4 people (15.4%) preferred other resources - video materials, apps without AI functionality, and dictionaries.

Students' choice of generative AI tools when learning Chinese is linked to the ability to quickly obtain explanations and feedback. Unlike the traditional textbook, which presents

material in a systematized but fixed way, AI lets learners ask clarifying questions and receive explanations that account for each student's specific difficulties. In learning Chinese, the character-based writing system, the tonal system, and the substantial differences from students' native languages create a wide range of individual difficulties that require additional explanation and practice to resolve. The dialogic format of AI tools allows the response content to be adapted to a particular user's request, increasing their demand in certain types of learning activities. The prevalence of digital technologies in students' everyday lives also makes such tools accessible and convenient for regular use. The use of the textbook alongside AI shows that students still need a systematized presentation of language material and regard traditional learning resources as an important complement to digital tools.

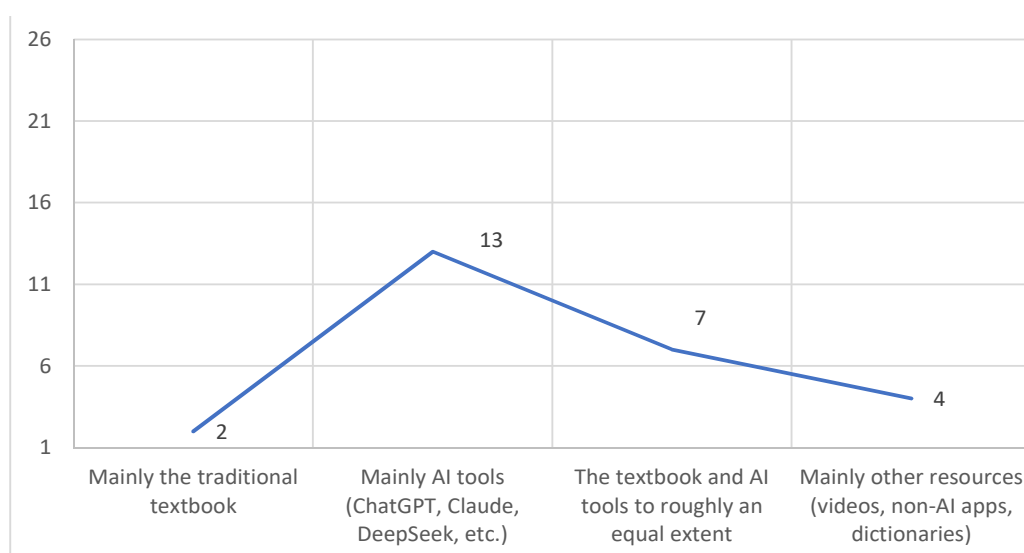
Table1

Students' Preferred Learning Tool in Self-Directed CFL Study

Option	frequency	%
Mainly the traditional textbook	2	7.7
Mainly AI tools (ChatGPT, Claude, DeepSeek, etc.)	13	50.0
The textbook and AI tools to roughly an equal extent	7	26.9
Mainly other resources (videos, non-AI apps, dictionaries)	4	15.4
Total	26	100.0

Figure 1

Students' Preferred Learning Tool in Self-Directed CFL Study (n=26)



Responses to the question about the tasks for which students turn to AI tools (Table 2; up to three options could be selected, percentages calculated from the number of respondents) reveal a distinct functional selectivity. Students most often turn to AI for conversational practice and constructing dialogues - this option was noted by 19 people (73.1%) - and for checking completed assignments (16 people; 61.5%). Memorizing and analyzing characters (11 people; 42.3%) and working on pronunciation and tones (9 people; 34.6%) rank in the middle. AI is used least often for translating and analyzing texts (7 people; 26.9%) and for explaining grammar (6 people; 23.1%). Notably, no respondent selected the option "I do not use AI tools for learning Chinese"; generative AI, in one function or another, is part of all respondents' independent practice. We obtained 68 responses from 26 respondents, for an average of about 2.6 options per person, indicating multifunctional use of AI among most students.

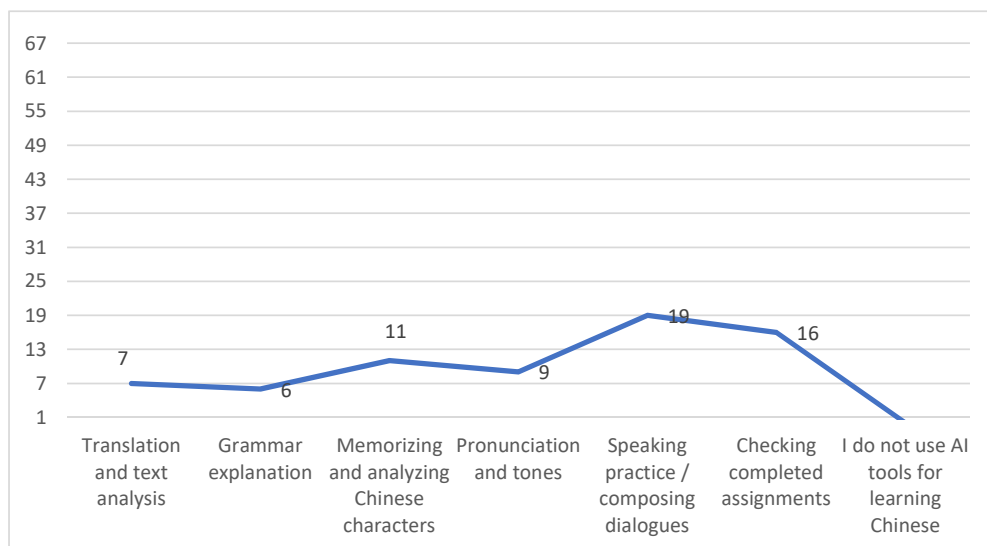
This pattern supports the following preliminary explanation. The lead in conversational

practice is logical: oral communication is the hardest to practice independently because it requires an interlocutor; dialogic AI compensates for this absence by providing a partner available at any time and reducing the fear of making mistakes characteristic of beginner-stage communication. The high proportion of requests to check assignments reflects the need for immediate feedback: the student receives an indication of an error immediately after completing the work, without waiting for class. The intermediate figures for characters and phonetics apparently reflect AI's partial applicability in these areas: it is useful for explaining character structure or the rules of tone formation but developing graphomotor writing and auditory-articulatory skills requires repeated practice, which a text-based interface cannot provide. The comparatively low proportions for translation and grammar explanation reflect that, at the beginner stage, these tasks are largely covered in the textbook and in classroom work with the instructor.

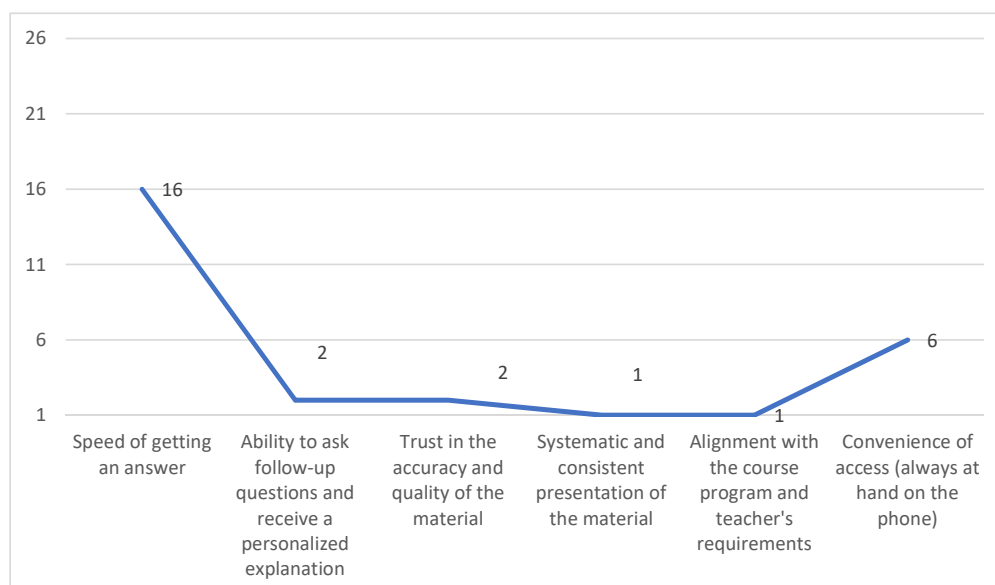
Table 2

CFL Learning Tasks for Which Students Use AI Tools

Task	frequency	% of respondents
Translation and text analysis	7	26.9
Grammar explanation	6	23.1
Memorizing and analyzing Chinese characters	11	42.3
Pronunciation and tones	9	34.6
Speaking practice / composing dialogues	19	73.1
Checking completed assignments	16	61.5
I do not use AI tools for learning Chinese	0	0.0
Total 68 responses from 26 respondents	68	-

Figure 2*CFL Learning Tasks for Which Students Use AI Tools (n=26)***Table 3***Main Factor Determining Students' Choice of Learning Tool*

Factor	frequency	%
Speed of getting an answer	16	57.1
Ability to ask follow-up questions and receive a personalized explanation	2	7.1
Trust in the accuracy and quality of the material	2	7.1
Systematic and consistent presentation of the material	1	3.6
Alignment with the course program and teacher's requirements	1	3.6
Convenience of access (always at hand on the phone)	6	21.4
Total	28	100.0

Figure 3*What mainly determines your choice of tool when studying Chinese?*

The distribution of responses to the question about the main factor in choosing a tool (Table 3; n=26, one option per respondent) reveals the dominance of pragmatic motives. More than half of the respondents (16 people; 57.1%) named the speed of obtaining an answer as the decisive factor; another 6 people (21.4%) indicated the convenience of access - the constant availability of the tool on the phone. Together, these two factors, reflecting responsiveness and availability, account for 78.5% of responses. Two respondents (7.1%) noted the possibility of asking a clarifying question and receiving a personalized explanation, and 7.1% reported trust in the accuracy and quality of the material. The least significant factors were the systematicity and consistency of the presentation of material (1 person; 3.6%) and alignment with the course program and the instructor's requirements (1 person; 3.6%): content- and methodology-related factors together accounted for only 14.3% of responses.

This structure of motives allows for the following preliminary explanation. The predominance of speed and availability is consistent with the very context of independent work: difficulty arises for the student at a specific moment - while doing homework or working through material - and the value of a tool is determined primarily by how quickly it can resolve the question that has arisen. When a smartphone is constantly at hand, and generative AI responds within seconds, the threshold for turning to it is low; the textbook, by contrast, requires searching for the relevant section and does not guarantee that the question difficulty is even addressed. The low shares of content-related factors - trust, systematicity, alignment with the course - do not necessarily mean that students attach no importance to them: it is more likely that, at the beginner stage of learning, these functions are by default assigned to the textbook and the instructor, and are therefore not perceived as a criterion of choice in the context of independent work. At the same time, the small number of respondents who indicated content-related motives likely reflects the group's continued orientation toward traditional sources. It should

also be noted that the dominance of speed over the possibility of personalized explanation (57.1% versus 7.1%) points to a predominantly instrumental rather than dialogic use of AI: students value it primarily as a means of quickly obtaining a ready-made answer, which raises for methodology the question of fostering deeper strategies of educational interaction with AI.

Discussion. The pilot survey results allow us to relate the preferences of students learning Chinese as a foreign language to the emerging body of international research on adopting AI tools in language education. The data show that 26 respondents (76.9%) prefer AI tools or combine them with the textbook equally. In contrast, only 2 people (7.7%) prefer the textbook alone, which is generally consistent with the overall trend of high readiness among learners of Chinese to use generative AI, documented in recent studies. Thus, Sun and Wang (2024), examining perceptions of ChatGPT among 120 CFL learners through the lens of the technology acceptance model, found that perceived usefulness, a growth mindset, and facilitating conditions significantly predict intention to use an AI tool. The predominance in our data of choice factors such as speed of obtaining an answer (57.1%) and the convenience of constant access from a phone (21.4%) - together accounting for almost four-fifths of all responses - corresponds substantively to the construct of perceived usefulness: students choose a tool not because of technological novelty but based on its ability to solve specific learning tasks at the moment they arise promptly.

At the same time, the structure of factors identified in the study allows this picture to be refined with respect to the beginner stage of learning. The fact that some respondents indicated trust in the accuracy and quality of the material (7.1%), systematicity of the presentation of material (3.6%), and alignment with the course program and the instructor's requirements (3.6%) as the main factors confirms that the textbook retains the function of a methodological framework that AI tools do not yet reproduce at this stage. This observation is consistent with the findings of Wei, Xu, and Wang (2026), who, drawing on data from

331 learners of Chinese, showed that trust in a tool is one of the strongest predictors of its adoption. In contrast, under conditions of already routine ChatGPT use, perceived ease of use and usefulness lose their predictive power with respect to usage intention. Applied to the results of this study, this means that students' choice between the textbook and AI is apparently determined not so much by an overall assessment of the technology's convenience as by differentiated trust in different sources for different learning tasks: content-related factors (trust, systematicity, alignment with the course), taken together, accounted for only 14.3% of responses, but it is presumably precisely these factors that characterize the smaller portion of the sample that retains an orientation toward the textbook, which indirectly supports the interpretation offered by Wei et al.

The distribution of responses to the second questionnaire item, which showed a concentration of AI use around conversational practice and dialogue construction (73.1%) and checking completed assignments (61.5%), with markedly less reliance on AI for grammar explanation (23.1%) and text translation and analysis (26.9%), finds parallels in empirical work on the functional boundaries of AI in CFL. Wen and Zhou (2025), having studied the use of generative AI by CFL learners in oral speech production tasks, characterized its role as cognitive scaffolding - an auxiliary support that assists but does not replace the learner's own independent language work; the high demand for AI specifically in dialogic practice observed in our data directly corresponds to this function, since AI serves as an accessible interlocutor and a source of immediate feedback. Chen, Wang, and Liu (2024), who documented the positive effect of ChatGPT on Chinese vocabulary acquisition, provide grounds for interpreting the intermediate figures for work with characters (42.3%) along the same lines. At the same time, the comparatively low proportion of requests to AI for grammar explanation and text translation, as well as the moderate proportion for working on pronunciation and tones (34.6%), may indicate that in tasks requiring systematic presentation of material and reliable verification,

as well as the training of perceptual and motor skills, students still rely on the textbook and the instructor. In contrast, the advantages of AI in speed and personalization are most fully realized in interactive and checking/correcting tasks.

Thus, the results of the pilot study do not confirm the notion of a linear displacement of the textbook by AI tools but rather point to an emerging functional distribution: AI is becoming established in the role of a prompt, personalized assistant and speech-practice partner. In contrast, the textbook retains the functions of a system-forming and verifying source. Notably, none of the 26 respondents selected the option "I do not use AI tools for learning Chinese," demonstrating the *de facto* ubiquity of AI in this group's learning practice. This interpretation aligns with the shift in research focus documented in the literature, moving from the question of "whether learners accept AI" to the conditions and boundaries of its pedagogically appropriate use. Given the pilot nature of the study and the limited sample size, the conclusions formulated here are preliminary and subject to verification on an expanded sample; a promising direction is seen in supplementing the quantitative data with interviews that would make it possible to reveal the mechanisms underlying students' differentiated trust in the textbook and AI across different aspects of the Chinese language.

Conclusions. The steady growth of interest in the Chinese language, driven by the expansion of economic, educational, and cultural cooperation with the PRC, coincided in time with the emergence of publicly available generative AI tools, which naturally raised for CFL teaching methodology the question of the place of new technologies in the pedagogical process and their relationship to traditional teaching tools. The study aimed at determining which factors govern the choice made by beginner-level students between the traditional textbook and AI tools in their learning practice.

The survey showed that generative AI has become an integral part of learning Chinese, but its use is not total; rather, it is selective. In answering the research question posed, it

can be stated that students' choice between the textbook and AI tools is determined primarily by pragmatic factors - the speed of obtaining an answer and the constant availability of the tool - while content- and methodology-related factors (trust in the accuracy of the material, the systematicity of its presentation, alignment with the course program) are significant for a smaller portion of learners and are associated with a retained orientation toward the traditional textbook. At the same time, the choice is task-dependent in nature: the same student turns to different tools depending on the type of learning task - AI is in demand where an interlocutor, immediate feedback, and prompt explanation are needed, while the textbook and the instructor retain the functions of a systematic and verifying source. This is therefore not a matter of traditional teaching tools being displaced, but of a spontaneously emerging functional division of tools, which so far has occurred without targeted methodological guidance.

The practical significance of the results obtained lies in the fact that they provide guidelines for such guidance: it is advisable for the instructor neither to prohibit nor to

ignore AI tools, but rather to integrate them into the pedagogical process in light of the identified zones of their effectiveness, while simultaneously fostering in students a critical attitude toward the accuracy of generated material and deeper strategies of educational interaction with AI that go beyond quickly obtaining a ready-made answer.

Prospects for further research are related, first, to expanding and diversifying the sample (students of different proficiency levels and from different universities), which will make it possible to test the robustness of the identified trends; second, to moving from a cross-sectional survey to longitudinal observation reflecting the dynamics of preferences as language competence grows; third, to supplementing the quantitative data with qualitative methods - interviews and analysis of real-life scenarios of students' interaction with AI - which will make it possible to reveal the mechanisms underlying the formation of trust in different sources. A separate direction involves developing and experimentally testing methodological models for integrating AI tools into teaching Chinese at the beginner stage.

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Forming Students' Ecological Culture Through Problem-Based Learning and a Virtual Laboratory

Abstract

Introduction. This study investigates the effectiveness of integrating problem-based learning and virtual laboratory technologies to develop ecological culture among university students. It aims to determine whether combining inquiry-based instructional strategies with digital simulation environments can enhance students' ecological knowledge, critical thinking skills, environmental responsibility, and practical engagement compared with traditional teaching methods. **Methodology and Methods.** A quasi-experimental design was applied involving undergraduate students in biology-related programs, divided into experimental and control groups. The experimental group was taught through problem-based learning activities supported by virtual laboratory platforms, while the control group received traditional instruction. Data were collected using diagnostic assessments, structured questionnaires, and performance-based evaluation tools to measure students' ecological knowledge, attitudes, and behavioral readiness. **Results.** The results indicate that students exposed to the integrated approach demonstrated higher levels of ecological understanding, improved analytical and problem-solving abilities, increased motivation, and greater participation in environmental learning activities than those in the control group. **Scientific novelty.** The study proves that combining problem-based learning with virtual laboratories produces a synergistic effect that strengthens both the cognitive and practical dimensions of ecological education. **Practical significance.** The developed integrated instructional model offers an effective approach to fostering ecological culture in higher education and supports the preparation of environmentally responsible, sustainability-oriented future professionals.

Keywords: ecological culture; problem-based learning (PBL); virtual laboratory; higher education; environmental education; educational technology; sustainable development education.

Introduction. In contemporary education, forming ecological knowledge and ecological culture has become a top priority because of growing global environmental challenges. Educational institutions are expected not only to transmit theoretical knowledge but also to develop students' critical thinking, problem-solving abilities, and environmental responsibility (Armstrong, 2011). Environmental education is a continuous process of learning and personal development aimed at forming ecological knowledge, values, and behaviors that promote responsible interaction with the environment and support human health.

Education for Sustainable Development (ESD) focuses on preparing individuals with ecological culture, systems thinking, and social responsibility. Such individuals can understand complex socio-environmental processes and make informed decisions at local and global levels to ensure a sustainable quality of life without compromising future generations (Wals & Blewitt, 2010).

A key component of modern sustainable pedagogy is developing ecological competence, which integrates knowledge, skills, and value-based attitudes that enable individuals to critically analyze and evaluate environmental

issues (Reen et al., 2025). Developing such competence is essential to building an environmentally responsible society capable of addressing contemporary ecological challenges (Mohan et al., 2024).

A comparative analysis of environmental education and ESD reveals several conceptual differences. First, ESD has a broader scope, focusing not only on environmental awareness but also on long-term behavioral and value-based transformation. Second, while environmental education often emphasizes the human–nature relationship from either an anthropocentric or ecocentric perspective, ESD promotes a more integrated and balanced approach. Third, ESD introduces a stronger ethical dimension, emphasizing responsibility toward future generations (Korotkova & Zakirova, 2020).

Furthermore, ESD promotes a subject–subject relationship between humans and nature, treating nature as an active partner rather than a passive object. It also emphasizes equal interaction between teacher and learner, fostering student-centered learning and intrinsic motivation (Wals & Blewitt, 2010). Modern research highlights that ESD relies on learner motivation supported by emotional engagement with nature and scientific understanding, which leads to responsible environmental behavior. In this context, education becomes a self-organizing system within a “learning society” (Korotkova & Zakirova, 2020).

Current studies emphasize that ESD is characterized by diverse content, interdisciplinary integration, and a combination of traditional and digital learning formats. It integrates natural sciences and humanities while maintaining a future-oriented perspective on global environmental issues (Wals & Blewitt, 2010). In addition, research on teacher education highlights the importance of innovative pedagogical technologies. Integrating digital tools enhances students’ digital literacy, critical thinking, and engagement in the learning process (Kerimbayeva et al., 2024; Meirbekov et al., 2024).

Recent studies also show that digital platforms and virtual learning environments can effectively develop ecological competence.

These tools improve students’ understanding of ecological processes and support the development of practical skills (Landa et al., 2023; Reen et al., 2025). Virtual laboratories boost students’ motivation and help them visualize complex biological systems (Asare et al., 2023; Brame, 2016).

Moreover, Problem-Based Learning (PBL) is widely recognized as an effective student-centered approach that enhances critical thinking, collaboration, and independent learning (Prince, 2004; Freeman et al., 2014). Through engagement with real-world problems, students develop the ability to analyze complex situations and propose evidence-based solutions (Sababha et al., 2016; Bagheri et al., 2013). Empirical studies confirm that PBL significantly improves student engagement and academic performance in higher education settings, while also promoting self-directed learning and higher-order thinking skills compared to traditional instructional methods (Ngereja et al., 2020; Bagheri et al., 2013).

In Kazakhstan, PBL implementation has shown positive outcomes in improving students’ creativity, engagement, and problem-solving abilities, although challenges related to methodological readiness and time constraints remain (Kerimkulova et al., 2016; Tungyshbay & Sainov, 2020). Overall, integrating innovative pedagogical approaches such as PBL and virtual laboratories represents a promising direction for enhancing ecological education and preparing future teachers with strong environmental competencies (Meirbekov et al., 2024).

This study aims to examine the effectiveness of integrating problem-based learning (PBL) and virtual laboratory technologies in enhancing university students’ ecological culture and to evaluate their impact on students’ ecological knowledge, attitudes, responsibility, and practical environmental engagement.

Materials and Methods. *Research Design.* This study used a mixed-methods quasi-experimental design to examine the effectiveness of integrating problem-based learning (PBL) and virtual laboratory technologies in developing students’ ecological culture. The research combined descriptive and inferential approaches

to provide both quantitative measurement and qualitative interpretation of learning outcomes. Pre-test and post-test measurements assessed changes in students' ecological culture.

Participants. The study included 120 third-year undergraduate students majoring in Biotechnology and Molecular Biology at Abai Kazakh National Pedagogical University. Participants were divided into an experimental group ($n = 60$) and a control group ($n = 60$). Both groups followed the same curriculum, while the instructional methods differed.

Instruments. We collected data using structured questionnaires, diagnostic tests, and academic performance assessments. The questionnaire used a five-point Likert scale (1 = strongly disagree, 5 = strongly agree) and measured four dimensions of ecological culture: ecological knowledge, ecological attitudes, ecological responsibility, and ecological action. In addition, the study included open-ended questions to explore students' perceptions of learning experiences with PBL and virtual laboratory environments.

Intervention. The experimental group was instructed through a combination of problem-based learning activities and virtual laboratory platforms, including PhET, CK-12, Labster, HHMI, and BioMan Biology. In contrast, the control group received traditional lecture-based instruction. The intervention included case-based ecological problem-solving tasks, collaborative group activities, and simulation-based laboratory exercises designed to promote active learning and practical engagement.

Ethical Consideration. The study followed the ethical principles of the Declaration of Helsinki and relevant national regulations on research involving human participants, as well as the Law of the Republic of Kazakhstan "On Personal Data and Their Protection" (No. 94-V of 21 May 2013). The research was carried out within the framework of regularly scheduled university courses, using instructional methods and freely available educational platforms already employed in higher education practice; it involved no medical, clinical, or biomedical procedures, no deception, and no collection of sensitive personal data. Under the institutional

regulations in force, studies of this type do not require review by a formal ethics committee. We observed all ethical safeguards described below throughout the study.

The administration of Abai Kazakh National Pedagogical University and the department responsible for the courses concerned granted permission to conduct the study. All participants were adult university students. Before the study began, they were informed of its aims, the procedures involved, the approximate time required for the questionnaires and tests, the voluntary nature of participation, and that the data would be used for research purposes only. All participants provided informed consent before the pre-test measurement.

Participants were informed that they could withdraw at any stage without giving reasons and that participation, refusal, or withdrawal would not affect whatsoever their course grades or their relationship with the teaching staff. To minimize perceived pressure arising from the status difference between instructor and student, participants completed the questionnaires anonymously, and the course instructor could not access responses in identifiable form. No incentives or rewards were offered for participation.

We paid particular attention to the equitable treatment of the two groups. The control group followed the full curriculum without any reduction in instructional content or contact hours, and no participant was disadvantaged by the group to which they were assigned. After the study, the materials and virtual laboratory resources used in the experimental condition were made available to the control group.

Questionnaire responses contained no names, student identification numbers, or other personal identifiers; individual records were coded numerically, and the codes linking pre-test and post-test responses were held separately and destroyed after the data were matched. We processed academic performance data in the same anonymized form. All data were stored on a password-protected device accessible only to the research team and are reported exclusively in aggregated form. Excerpts from the open-ended responses are presented without any

details that would permit the identification of individual participants.

We analyzed quantitative data using descriptive and inferential statistics. Independent-samples ANOVA was used to compare group differences, while ANCOVA controlled for pre-test scores. Spearman's correlation analysis examined relationships among variables. The researchers analyzed qualitative data from open-ended responses through thematic coding and identified key patterns such as problem-solving, critical thinking, collaboration, and learner engagement. Expert review established instrument validity, and Cronbach's alpha confirmed internal consistency. All statistical analyses were conducted at the $p < 0.05$ significance level.

Results. This study describes changes in the learning process of third-year students studying biotechnology and molecular biology at Abai Kazakh National Pedagogical University. During the study, the students' level of ecological

culture, their attitude toward the Problem-Based Learning (PBL) method, and the experience of using virtual laboratory platforms (PhET, CK-12, Labster, HHMI, BioMan Biology) were assessed in stages, along with the students' ecological culture levels, their attitudes toward problem-based learning (PBL), their experience using virtual laboratory platforms, and the effectiveness of integrating these two methods. A total of 120 students participated, and the analysis included only fully and qualitatively completed responses.

Initial level of ecological culture

At the beginning of the study, students' ecological culture was assessed according to four main components: ecological knowledge, critical thinking, practical ecological action, and ecological responsibility. The results obtained showed that although the students had a general understanding of environmental issues, their ability to conduct in-depth, systematic analysis was insufficient.

Table 1

Initial level of ecological culture

Component	Mean value	Description
Ecological knowledge	2.88	Average
Critical thinking	2.61	Slightly below average
Practical activity	2.45	Low
Environmental Responsibility	2.70	Average

These results indicate that students have a foundation in ecological knowledge, but their ability to apply it in real-life situations is weak. In particular, the low practical performance indicator demonstrates that students have little direct experience engaging with ecological issues.

Impact of Problem-Based Learning (PBL)

Table 2

Dynamics of the PBL impact

Indicator	Pre-test	Post-test	Growth
Ecological knowledge	2.88	3.52	+0.64
Critical thinking	2.61	3.44	+0.83
Proposing a solution	2.49	3.40	+0.91
Participation	2.45	3.36	+0.91

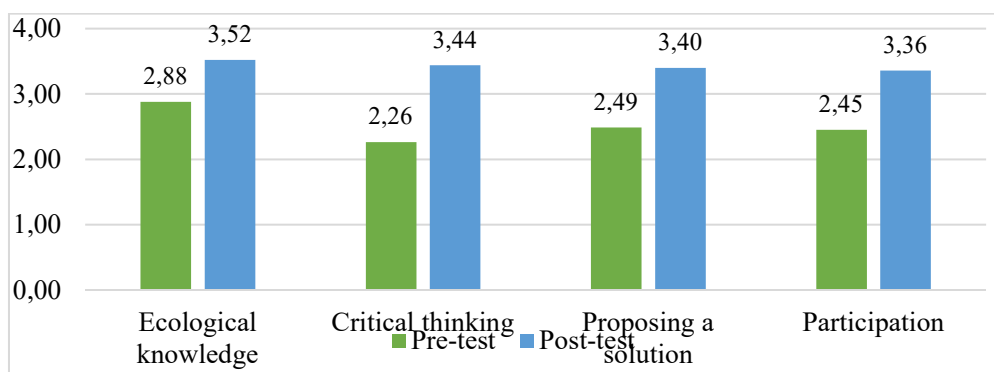
After introducing PBL, the greatest increases were in the ability to propose

After the introduction of PBL, students were presented with case studies based on real-world ecological problems (biotechnological waste, the impact of genetic modification on ecosystems, and bioremediation issues). During this phase, students' skills in analysis, argumentation, and solution proposal increased significantly.

solutions and in active participation in the learning process.

Figure 1

Dynamics of the PBL impact



This indicates that students shifted from passive listeners to active researchers and decision-makers.

Impact of Virtual Laboratory Tools

Virtual laboratories were used in the learning process to visualize and model complex biological and ecological processes. Each platform affected a specific cognitive level.

Table 3

Impact of virtual laboratory platforms

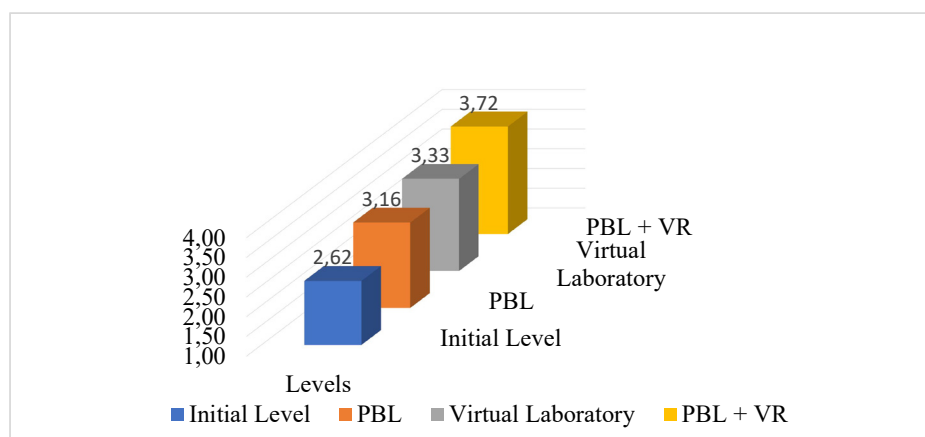
Platform	Main activity	Results
PhET	Main visualization	Understanding made easier
CK-12	Consolidation of theory	Knowledge organized
Labster	Scientific Modeling	Analytical thinking increased
HHMI	Biological Systems	Developed a deep understanding
BioMan Biology	Game elements	Motivation increased

These results show that virtual labs not only provide information but also increase student motivation and allow a hands-on understanding of complex biological processes. While the Labster and HHMI platforms strengthened scientific thinking and modeling skills, BioMan

Biology made the learning process engaging and interactive. The group that combined PBL with a virtual laboratory achieved the highest results. This model enabled students to simultaneously understand the theory, model it in a virtual environment, and propose a concrete solution.

Figure 2

Dynamics of the development of ecological culture



This chart shows that the greatest increase in students' ecological culture was observed in the combined method. The sharp increase in scores, especially when using PBL and VR,

demonstrates the synergistic effect of the two methods.

One-way ANOVA was used to determine differences among the groups.

Table 4

ANOVA results

Variable	F	p-value	Conclusion
Teaching method	15.21	<0.001	Significant effect
Group type	6.48	0.002	Significant
Interaction	5.91	0.004	Significant

The ANOVA results showed that the teaching method had a statistically significant effect on students' ecological culture. In particular, integrating PBL and the virtual laboratory

yielded significantly higher results compared to the individual methods.

ANCOVA analysis was conducted to control baseline differences.

Table 5

ANCOVA results

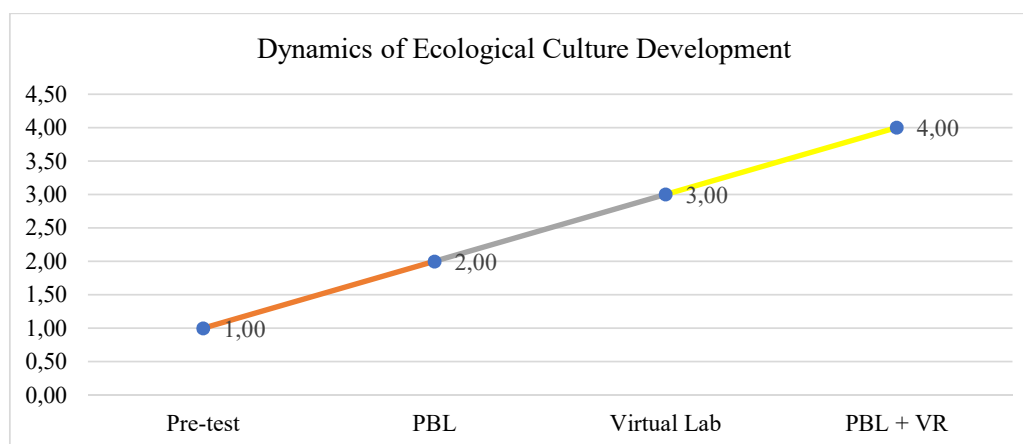
Measure	F	p-value
Pre-test (covariate)	9.12	0.001
Teaching method	17.34	<0.001

Although the pre-test effect was statistically significant, the teaching method's impact remained significant even after controlling for it. These results demonstrate that the effects of

PBL and the virtual laboratory are genuine and sustained. Summarizing the research results, the dynamics of changes in students' ecological culture were as follows:

Figure 3

Dynamics of changes in students' ecological culture



Pre-test → initial level (low-average)

PBL → increased critical thinking and participation

Virtual Lab → increased understanding and motivation

PBL+VR → highest level (integrated development)

Discussion. The findings indicate that integrating problem-based learning and virtual laboratory technologies positively affected students' ecological culture. Ecological knowledge, critical thinking, environmental responsibility, motivation, and practical engagement improved. These results are consistent with the principles of constructivist and student-centered learning. Both approaches emphasize active participation and constructing knowledge through experience (Wals & Blewitt, 2010). The findings suggest that combining problem-based learning and virtual laboratories can support both the cognitive and value-oriented aspects of ecological education.

These findings align with previous international studies reporting the positive effects of problem-based learning on students' academic achievement and higher-order thinking skills. Ngereja et al. (2020) found that project-based learning significantly improves students' critical thinking, collaboration, and active participation in higher education. Similarly, Bagheri et al. (2013) reported that students exposed to problem-based learning demonstrate stronger self-directed learning abilities than students taught through traditional instructional approaches. The current study confirms these findings and additionally demonstrates that PBL positively influences ecological responsibility and environmental awareness.

The study also showed that students became more actively engaged in identifying and solving ecological problems after participating in PBL activities. This result aligns with Hira and Anderson (2021), who emphasized that project-based and inquiry-based learning approaches increase students' intrinsic motivation and participation in online and collaborative learning environments. In contrast to traditional lecture-based instruction, PBL encourages learners to become active researchers and decision-makers, thereby strengthening independent analytical thinking and reflective learning skills. Furthermore, problem-based learning enabled students to approach ecological issues critically and analyze their cause-and-effect relationships in greater depth. Through group assignments and the analysis of real-life

environmental situations, students developed skills in substantiating their opinions with scientific evidence and making collaborative decisions. These changes indicate that PBL not only facilitates the acquisition of ecological knowledge but also enhances students' sense of responsibility, research engagement, and inclination toward sustainable environmental behavior.

Recent studies in science and environmental education also support the findings on virtual laboratory technologies. Asare et al. (2023) concluded that virtual laboratories improve student engagement, satisfaction, and conceptual understanding by allowing learners to visualize scientific processes interactively. Similarly, Landa et al. (2023) highlighted that innovative digital technologies enhance students' motivation and support deeper understanding of complex scientific concepts. The present study extends these findings by demonstrating that virtual laboratories are effective not only for improving conceptual understanding but also for strengthening ecological culture and environmentally responsible behavior. Digital learning environments also increase student engagement and improve learning outcomes by enabling interactive, flexible access to scientific content.

Virtual learning environments have been shown to significantly improve students' engagement and learning motivation by providing interactive and simulation-based experiences. These results align with the present study, where virtual laboratory platforms helped students better understand complex ecological processes and apply theoretical knowledge in practice. A key contribution of this study is identifying the synergistic effect of combining problem-based learning with virtual laboratory technologies (Makransky & Mayer, 2020). Students who used both approaches achieved higher results than those exposed to either method alone. This finding differs from some previous studies that examined PBL or virtual laboratories independently. The integrated model used in the present research allowed students to combine theoretical understanding with practical experimentation and collaborative

problem-solving. This suggests that integrating digital simulation technologies with inquiry-based pedagogy creates a more comprehensive learning environment for environmental education.

This finding indicates that combining inquiry-based pedagogy with immersive digital tools creates a more effective learning environment by supporting both conceptual understanding and active knowledge construction. Previous studies have also confirmed that integrated digital learning environments significantly enhance students' cognitive engagement, motivation, and conceptual understanding compared to single-method instruction.

The findings also support the principles of Education for Sustainable Development, which prioritize learner-centered approaches, critical thinking, and solving real-world problems. Participation in virtual ecological simulations and collaborative case analyses enhanced students' understanding of sustainability issues and increased their readiness to apply ecological knowledge in practical contexts. From this perspective, these instructional approaches effectively implement the core principles of Education for Sustainable Development within the learning process. In particular, these learning activities contribute to students' comprehensive understanding of ecological issues, their ability to evaluate them critically, and the development of responsible decision-making skills aligned with sustainable development goals.

From a pedagogical perspective, the findings emphasize the importance of integrating innovative technologies into higher education curricula. Contemporary environmental education requires more than theoretical instruction. Students also need opportunities to engage with authentic ecological problems. Integrating problem-based learning and virtual laboratories can support this process. It also contributes to the development of digital literacy, scientific reasoning, and sustainability-oriented thinking.

Despite the positive findings, several limitations should be acknowledged. The study was conducted in a single educational context and involved a relatively small sample, which

may limit the generalizability of the findings. In addition, some indicators, including motivation and engagement, were based on self-reported data and may contain subjective bias. Future studies should include larger, more diverse participant groups and examine the long-term impact of integrated digital and inquiry-based learning approaches on ecological culture development.

Overall, the findings suggest that integrating problem-based learning and virtual laboratory technologies can support the development of ecological culture in higher education. The study provides empirical evidence for combining inquiry-oriented pedagogy with digital learning tools in environmental education. These results may help further develop technology-enhanced approaches to ecological education.

Future research should expand the sample size, include multiple universities, and investigate long-term effects; additionally, the experimental design needs to be refined to clearly distinguish the individual effects of PBL and the virtual laboratory. A deeper analysis of qualitative data will allow for a better understanding of students' learning experiences.

Conclusion. This study comprehensively demonstrated the importance of Problem-Based Learning (PBL) and virtual laboratories in fostering students' ecological culture. The study results showed that although students' initial level was average, their ecological knowledge, critical thinking skills, practical abilities, and level of responsibility increased significantly through a specially organized learning process. Problem-based learning promotes students' active cognitive engagement. It supported the analysis of real-world ecological problems and independent decision-making. It also encouraged using scientific evidence in problem-solving. This method increased students' interest in learning and strengthened their independent learning skills. Virtual laboratories supported the visualization of complex biological and ecological processes. This helped students develop a deeper understanding of the subject matter. It also strengthened the connection between theoretical knowledge and practical application.

The study's main conclusion is that combining problem-based learning with virtual laboratories can effectively support the development of students' ecological culture. This integration improved ecological knowledge, environmental awareness, responsibility, and practical application skills. The findings indicate that the proposed approach supports both cognitive and value-oriented components of ecological education. It also provides students with opportunities to apply acquired knowledge in real-life environmental contexts. Furthermore,

the findings support the relevance of sustainable development principles in biology teacher education. They also highlight the importance of innovative pedagogical approaches in preparing future biology teachers. Integrating problem-based learning and virtual laboratories can support the development of ecological culture, critical thinking, and professional adaptability. These competencies are essential for responding to contemporary educational and environmental challenges.

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Effectiveness of an Integrative Model for Developing Soft Skills: an experimental study in general education institutions

Abstract

Introduction. In the contemporary education system, acquiring subject-specific knowledge alone is no longer sufficient; therefore, developing students' soft skills, including communication, teamwork, critical thinking, self-management, and learning motivation, has become an important educational priority. In general education institutions in particular, there is an increasing need to provide a scientific basis for pedagogical models aimed at the systematic and purposeful development of these skills. In this regard, the present study is relevant because it experimentally evaluates the effectiveness of an integrative model for developing soft skills. This study aimed to develop an integrative model for fostering soft skills in general education institutions, implement it in teaching and learning, and experimentally assess its impact on students' personal, social, and cognitive development. **Methodology and Methods.** The study used a pedagogical experiment with a mixed-methods approach combining quantitative and qualitative research methods. The study used questionnaires, tests, classroom observations, and interviews to collect data. The researchers developed an analytical framework to assess soft skills and analyzed the collected data using Jamovi statistical software. A total of 238 students participated in the study and were divided into experimental and control groups. The experiment was conducted in several general education institutions in the Turkistan region. **Scientific novelty.** The findings showed that implementing the integrative model significantly improved communication, teamwork, self-management, learning motivation, and cognitive soft skills among students in the experimental group compared with those in the control group ($p < 0.001$). In addition, modular training programs for teachers, professional experience-sharing activities, and webinars for parents helped improve the effectiveness of the educational process, adding *practical significance*. The findings support the integrative model for developing soft skills as an effective pedagogical solution that can be implemented in general education institutions.

Keywords: soft skills, integrative model, general education institutions, pedagogical experiment, analytical framework.

Introduction. In recent years, integrative and innovative pedagogical approaches have been widely investigated as potential solutions to this issue. In particular, generative artificial intelligence has been increasingly examined as a means of supporting personalized learning, student engagement, and the development of transferable competencies when it is integrated within a pedagogically structured learning environment (González-Rico & Sintés, 2024; Haroud & Saqri, 2025). Such environments

can facilitate students' active participation in the educational process while providing flexible forms of learning support. Research has also substantiated the effectiveness of microlearning and flipped learning approaches in developing soft skills. Short, purposefully designed learning modules help optimize cognitive load, support long-term knowledge retention, and facilitate the development of specific skills (Al-Zahrani, 2024; Bedoya et al., 2024). These approaches are particularly

suitable for learners studying in digital environments.

Furthermore, developing a feedback culture and professional reflection is an important component of soft skills development. Exchanging opinions and providing feedback play a significant role in fostering students' communication abilities, responsibility, and professional thinking (Ellegaard et al., 2024). The increasing integration of artificial intelligence into education has further heightened the importance of soft skills. Generative AI tools are increasingly regarded as effective means of supporting the development of learners' critical thinking, information analysis, and self-regulation skills (Pulk & Koris, 2025; González-Rico & Sintés, 2024; Haroud & Saqri, 2025; Hikmawati & Mohammad, 2025; Imron et al., 2021; Jainuri et al., 2025). However, effective use of these technologies requires implementation within a pedagogically grounded, well-structured model. Developing soft skills has also shown positive outcomes in language-related subjects and written assignments. In particular, essay-writing activities have been found to enhance learners' critical thinking significantly, ability to express independent opinions, and reflective skills (Ramankulova et al., 2025). This confirms the effectiveness of integrating soft skills development into subject-specific content.

Recent research also emphasizes the educational and employment relevance of soft skills. Rybowska (2024) found that students were aware of soft skills and generally regarded them as important in professional contexts, while also identifying a need for more systematic soft-skills training within academic curricula. Similarly, Yan and Mohamad Nasri (2025) reported that systematic soft-skills development in higher education was associated with stronger early employment outcomes. Although these studies focus on higher education, their findings support the importance of developing communication, teamwork, problem-solving, and self-management competencies earlier in the educational pathway. In this context, an experimental investigation of the effectiveness of an integrative model for developing soft

skills in general education institutions is highly relevant. This model aims to support students' personal, social, and academic development by integrating traditional teaching methods, digital technologies, microlearning, and elements of artificial intelligence.

The present study enables an experimental assessment of the effectiveness of an integrative model for soft skills development and its influence on students' learning engagement, critical thinking, communication, and social skills. The findings may provide a scientific and methodological basis for improving contemporary pedagogical approaches to soft skills development and implementing them in general education institutions. Contemporary educational research regards soft skills development as a complex, multidimensional phenomenon. The expansion of networked and digital learning environments has created a need to reconsider how these skills develop. Jaldemark et al. (2022) demonstrate that networked learning models based on interaction and collaborative activity among learners play an important role in developing communication, collaboration, and reflection skills. The authors argue that social interaction and experience within digital environments contribute to the natural development of soft skills.

Overall, the reviewed scholarly literature clearly demonstrates the need to implement an integrative model for soft skills development. By combining microlearning, networked learning, artificial intelligence, and subject-specific content, such a model can comprehensively support learners' personal and professional development. Based on the theoretical analysis and the findings of the experimental study, the following principal research questions were formulated:

How does an integrative model for developing soft skills in general education institutions influence students' personal, social, and cognitive development?

Is there a statistically significant difference between the experimental and control groups in terms of the development levels of soft and cognitive skills?

How do modular training programs for teachers, professional experience-sharing

among educators, and webinars for parents contribute to improving the effectiveness of soft skills development?

This study aims to develop an integrative model for fostering soft skills in general education institutions, implement it in the teaching and educational process, and experimentally evaluate its impact on students' personal, social, and cognitive development. This article was prepared within the framework of the Professor-Researcher Program of Khoja Akhmet Yassawi International Kazakh-Turkish University.

Materials and Methods. The study was designed as a pedagogical experiment using a mixed-methods research approach that combined quantitative and qualitative methods. The research design aimed to evaluate the effectiveness of an integrative model developed to foster soft skills among students in general education institutions. The quantitative component assessed students' social, personal, and cognitive soft skills and compared the performance of the experimental and control groups before and after implementing the integrative model. The qualitative component complemented the quantitative findings through pedagogical observations and interviews, providing additional information on students' engagement, interaction, participation in group activities, and experiences during the educational process. Before the experimental stage, the study reviewed national and international scholarly literature on soft skills development and integrative pedagogical approaches. The researchers identified relevant publications through Web of Science, Scopus, and Google Scholar. The review prioritized studies published between 2015 and 2025. The literature search included the keywords "soft skills," "integrative model," "general education institutions," "pedagogical experiment," "analytical framework," and related terms. The theoretical analysis established the conceptual basis of the integrative model and the analytical framework used in the study's empirical stage.

Participants. A total of 238 students participated in the pedagogical experiment. Of these, 120 students were assigned to the control

group (CG), and 118 to the experimental group (EG).

The study was conducted in five general education institutions located in Turkistan, Kazakhstan, under the Department of Education of Turkistan City, Education Directorate of the Turkistan Region:

Municipal State Institution "General Education School No. 32";

Municipal State Institution "General Education School No. 33";

Municipal State Institution "General Education School No. 34";

Zhumabek Tashenov IT School-Lyceum No. 23;

Damu-Bilim 1 School Limited Liability Partnership.

Both groups participated in the study's pre-test and post-test stages. The pre-test was administered before implementation of the experimental intervention to determine students' initial level of cognitive soft skills. A comparison of pre-test scores showed no statistically significant difference between the experimental and control groups, indicating comparable baseline levels before the intervention. After implementing the integrative model, both groups completed the post-test. The post-test results were then used to evaluate differences between experimental and control groups and determine the effectiveness of the pedagogical intervention.

Data Collection Tools. Data was collected using a soft skills questionnaire, a cognitive soft skills test, pedagogical observations, and interviews. These instruments were incorporated into an analytical framework developed to assess different dimensions of students' soft skills.

Soft Skills Questionnaire. The questionnaire assessed students' social and personal soft skills. It consisted of 12 items structured around four main constructs: communication skills, teamwork ability, self-management and responsibility, and learning motivation. The communication skills construct assessed students' ability to express their thoughts clearly and confidently, share their opinions, and listen to and understand others' views. These skills were considered important indicators of students' participation in classroom

interaction and group activities. The teamwork ability constructs assessed students' capacity to collaborate with others, share responsibility for achieving a common goal, and participate in joint decision-making. The study paid particular attention to students' interaction in project-based and collaborative learning activities. The self-management and responsibility constructed reflected students' ability to manage their time, complete assigned tasks independently, and demonstrate responsibility and autonomy in the learning process. Learning motivation constructed assessed students' interest in learning, active participation in lessons, and level of intrinsic motivation. The questionnaire employed a five-point Likert scale. Responses were coded as follows: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. The questionnaire's internal consistency was assessed using Cronbach's alpha. The overall Cronbach's alpha for the 12-item questionnaire was .823, indicating an acceptable level of internal consistency.

Cognitive Soft Skills Test. A test assessed students' soft cognitive skills. The test was evaluated on a 20-point scale, with higher scores indicating a higher level of cognitive soft skills. The test was administered twice. The pre-test was conducted before implementing the integrative model to assess students' initial level of cognitive soft skills and to examine comparability between the control and experimental groups. The post-test was administered after completion of the experimental intervention to assess changes in cognitive soft skills and determine differences between the two groups.

Pedagogical Observation. Pedagogical observation was used to obtain qualitative information about students' participation in the educational process. Particular attention was paid to students' engagement in learning activities, participation in group and project-based tasks, interaction with peers, communication, and ability to work collaboratively. The observations were used as supplementary evidence to support the interpretation of the quantitative questionnaire and test findings.

Interviews. Interviews provided additional qualitative information about students' expe-

riences during the implementation of the integrative model. The interview component focused on students' engagement in learning, interest in group and project-based activities, communication with peers, and ability to express their ideas. The interview findings were then categorized by key themes and compared with the quantitative results.

Data Collection Process. The data collection process followed a sequential order. At the initial stage, the pre-test was administered to students in both the experimental and control groups. The pre-test aimed to determine the initial level of cognitive soft skills and establish whether the two groups were comparable before the experimental intervention. The integrative model for developing students' soft skills was then implemented in the educational process. The intervention included activities to systematically develop communication, teamwork, critical thinking, self-management, responsibility, and motivation to learn. To support the implementation of the model, a modular teacher training program was developed and piloted. The program strengthened teachers' theoretical and practical understanding of soft skills development and supported the integration of relevant pedagogical strategies into teaching practice. Within the modular program, teachers participated in practical sessions that included role-playing activities, group and small-team tasks, case-based analysis of pedagogical situations, and reflective exercises. These activities were intended to facilitate the exchange of professional experience and strengthen teachers' ability to apply soft skills development strategies in the educational process.

Professional support was also provided through round-table discussions and professional dialogue sessions organized among teachers from the participating schools. During these activities, teachers discussed the effectiveness of the implemented methods, difficulties encountered during the intervention, examples of lesson activities, and practical approaches to developing students' communication, teamwork, and critical-thinking skills. The intervention incorporated parental involvement through

specialized webinars. During these webinars, parents received scientific and methodological recommendations for developing students' communication, social, and self-management skills in the family environment. The intervention also addressed issues related to responsibility, emotional stability, self-regulation, and effective parent-child interaction. Throughout the implementation period, data were collected using questionnaires, tests, pedagogical observations, and interviews. After completion of the experimental intervention, the post-test was administered to students in both groups. The collected quantitative and qualitative data were then prepared for statistical and content analysis.

Ethical Consideration. The Ethics Committee of Khoja Akhmet Yassawi International Kazakh-Turkish University, Kazakhstan granted ethical approval for this study (Ref. No. 46, [22.10.2025]).

Data Analysis. The study used questionnaires, tests, pedagogical observations, and interviews. The collected quantitative data were analyzed using the Jamovi statistical software. Cronbach's alpha was calculated in Jamovi to assess the questionnaire's internal consistency. Values above 0.70 were considered indicative of an acceptable level of reliability. The one-sample t-test is a statistical test used to analyze values obtained from a single administration of a questionnaire. The formula required to calculate the one-sample t-test is presented in Equation (1):

$$t = \frac{\bar{X} - \mu_0}{\frac{S}{\sqrt{n}}} \quad (1)$$

μ_0 – is the hypothesized population mean.

Independent-samples t-test: Equation (2) presents the formula used to calculate the independent-samples t-test.

$$t = \frac{\widehat{X}_1 - \widehat{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \quad (2)$$

Qualitative data were analyzed using content analysis. The interview findings were classified according to key thematic categories and

interpreted in comparison with the quantitative data.

Results. *Development of Modular Training Programs for Teachers*

As part of the study, modular training programs for teachers were developed to support the effective organization of the process of developing students' soft skills. In line with contemporary educational requirements, these programs were designed to enhance teachers' professional competence and enable them to acquire pedagogical and psychological mechanisms for systematically developing soft skills in the educational process. The programs aimed to deepen teachers' theoretical knowledge of integrating soft skills into teaching and educational activities, improve their practical expertise, and develop their ability to apply innovative pedagogical methods. In line with this aim, the modular programs were designed with a flexible structure adapted to teachers' professional practice. The training module entitled "The Psychology of Soft Skills Development" was introduced as an example of the modular program. This module was intended to explain the psychological and pedagogical foundations of soft skills development. It provided a comprehensive examination of the characteristics of an individual's social, emotional, and communicative development. It covered the concept and structure of soft skills, students' age-related psychological characteristics, mechanisms for fostering learning motivation, the role of emotional intelligence, and strategies for its development. The module included a series of practical sessions to integrate theoretical knowledge with hands-on activities. During these sessions, teachers participated in role-playing activities, group and small-team tasks, analyses of authentic pedagogical situations through case studies, and reflective exercises to develop soft skills. These activities facilitated the exchange of professional experience and ideas among teachers and supported the purposeful application of effective methods for developing students' soft skills in the teaching process. Thus, the modular training programs improved teachers' professional preparation, supported the

implementation of the integrative model for soft skills development in practice, and enhanced the quality of teaching and educational processes in general education institutions.

Exchange of Professional Experience Among Teachers

During the project, the participating teachers organized professional experience-sharing activities to promote interaction and share effective pedagogical practices. In particular, round-table discussions and professional debates examined the practical implementation outcomes of the integrative model aimed at developing soft skills. The professional experience-sharing activities strengthened teachers' professional reflection and contributed to the broader dissemination of effective pedagogical practices aimed at developing soft skills through collaborative analysis and mutual support. In addition, such interaction supported teachers' professional development and improved the quality of implementing innovative methods in general education institutions.

Webinars for Parents

To actively involve parents in developing students' soft skills, the study organized a series of specialized webinars. These webinars were designed to help parents support their children's personal and social development with informed guidance. During the webinars, parents received scientific and methodological recommendations on how to develop students' communication, social, and self-management skills in the family environment, enhance their sense of responsibility, foster emotional stability, and strengthen self-regulation abilities. In addition, the webinar discussed in detail the psychological and pedagogical features of establishing effective parent-child interaction and partnership-based relationships. The webinars were organized in an interactive format, enabling parents to share their experiences, obtain answers to relevant questions, and analyze real-life situations. This, in turn, enhanced parents' role in developing soft skills and contributed to strengthening cooperation between schools and families.

As a result, the webinars for parents were identified as an important component of the educational process, enabling the effective use

of family potential in developing students' soft skills and ensuring the integrity and continuity of the educational process. To evaluate the effectiveness of the pedagogical methods implemented during the study, the researchers conducted monitoring and comparative analyses using the developed analytical framework. A total of 238 students participated in the study: 120 in the control group (CG) and 118 in the experimental group (EG). The experiment was conducted at General Education Schools No. 32, No. 33, and No. 34, Zhumabek Tashenov IT School-Lyceum No. 23, and the private school Damu-Bilim 1. The research data were collected through the questionnaire, testing, and interview components of the analytical framework and subsequently subjected to statistical analysis.

Questionnaire Component

The questionnaire component assessed students' social and personal soft skills. In accordance with the proposed analytical framework, students' soft skills were examined across four principal dimensions, or constructs. These constructs were theoretically grounded and enabled a comprehensive assessment of students' personal and social development within the teaching and educational process.

The first dimension was communication skills. This construct reflected students' ability to express their thoughts clearly and confidently, articulate their opinions, and listen to and understand others' perspectives. Communication skills were regarded as an important indicator of students' classroom engagement and interaction in group settings. The second dimension was teamwork ability. This construct included students' capacity to work collaboratively in a group, share responsibility in achieving a common goal, and participate in joint decision-making. Teamwork ability was considered particularly important in project-based and collaborative learning environments. The third dimension was self-management and responsibility. This construct reflected students' ability to manage their time effectively, complete assigned tasks independently, and demonstrate autonomy in the learning process. Self-management skills were regarded as a key factor directly

influencing students' academic achievement. The fourth dimension was learning motivation. This construct was intended to assess students' interest in learning, active participation in lessons, and level of intrinsic motivation. Learning motivation was regarded as a driving force in developing soft skills.

Each construct was measured with three to five questionnaire items, which increased the reliability of the collected data and facilitated processing in Jamovi statistical software. The questionnaire employed the widely used

five-point Likert scale as the measurement instrument. Students rated their responses as follows: "1 – strongly disagree," "2 – disagree," "3 – neutral," "4 – agree," and "5 – strongly agree." This scale allowed quantification of students' attitudes toward each statement. Cronbach's alpha coefficient was calculated to determine the internal consistency of the questionnaire component and the reliability of the measurement instrument. The reliability analysis was conducted using the Jamovi statistical software (Table 1).

Table 1

Results of the Internal Consistency Assessment of the Questionnaire

Reliability Statistics	
Cronbach's alpha	Number of items
.823	12

Note. The questionnaire consisted of 12 items. The obtained Cronbach's alpha value (.823) indicates satisfactory internal consistency.

The calculation showed that the overall Cronbach's alpha coefficient for the questionnaire component was 0.823. According to the relevant literature, an alpha coefficient above 0.70 indicates an acceptable level of instrument reliability, whereas a value above 0.80 demonstrates high internal consistency.

Therefore, the obtained result confirms the homogeneity of the questionnaire's internal structure and the consistency among the measured indicators. A descriptive statistical analysis was conducted based on the responses of 238 students obtained through the questionnaire component (Table 2).

Table 2

Results of the Descriptive Statistical Analysis of the Soft Skills Assessment Questionnaire

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
N	238	238	238	238	238	238	238	238	238	238	238	238
Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean	3,53	3,47	3,45	3,50	3,45	3,40	3,43	3,51	3,46	3,53	3,42	3,47
Median	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00
Standard Deviation	0,979	0,940	0,987	0,940	1,00	0,948	0,960	0,958	0,912	0,962	0,933	0,953
Min	2	2	2	2	2	2	2	2	2	2	2	2
Max	5	5	5	5	5	5	5	5	5	5	5	5

Note. *M* = mean; *Mdn* = median; *SD* = standard deviation. Responses were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). No missing responses were identified.

No missing values were identified for any questionnaire item, indicating that the dataset was complete and suitable for statistical analysis. The mean values ranged from 3.40

to 3.53, suggesting that students' soft skills development was above average. Most medians were 3.00, while several items had a median of 4.00, indicating that most students tended

to agree with the corresponding statements. Standard deviations ranged from 0.91 to 1.00, indicating a relatively consistent response pattern and stable data. A total of 238 students participated in the study, including 120 students in the control group and 118 students in the experimental group. The test results were analyzed using a 20-point assessment scale, where higher scores indicated a higher level of development of students' cognitive soft skills. The test data were processed using Jamovi, which enabled descriptive and comparative

analyses. The testing component served as an objective data source for evaluating the effectiveness of the implemented pedagogical methods. It provided a statistical basis for identifying differences between the control and experimental groups. The pre-test was administered to determine the students' initial level of cognitive soft skills. A total of 120 students from the control group and 118 students from the experimental group participated in the assessment. The evaluation used a 20-point scale (Table 3).

Table 3

Comparison of the Initial Test Results of the Experimental and Control Groups (Pre-Test)

Group	N	M	Mdn	SD	SE	t	df	p
CG	120	10.70	11.00	2.27	0.208	1.14	236	.256
EG	118	11.10	11.00	2.14	0.197	—	—	—

Note. CG = control group; EG = experimental group; M = mean; Mdn = median; SD = standard deviation; SE = standard error. The independent-samples *t* test indicated no statistically significant difference between the groups at the pre-test stage, $t(236) = 1.14$, $p = .256$.

According to the descriptive statistics, the control group had a mean score of ($M = 10.7$) ($SD = 2.27$), while the experimental group had a mean score of ($M = 11.1$) ($SD = 2.14$). The median value was 11.0 in both groups, indicating that the students' initial performance levels were comparable. The standard error values were ($SE = 0.208$) for the control group and ($SE = 0.197$) for the experimental group, confirming data stability. An independent-samples *t*-test was conducted to determine whether the initial scores differed significantly between the control and experimental groups. The analysis yielded ($t = 1.14$), ($df = 236$), and ($p = 0.256$). The result indicated no statistically

significant difference between the groups ($p > 0.05$). The pre-test findings confirmed that the control and experimental groups had comparable baseline levels. This indicates that the two groups were equivalent in cognitive soft skills before the experiment began and provides a scientific basis for attributing any subsequent differences in the post-test results to the effects of the implemented pedagogical methods. The post-test was administered after completion of the experimental intervention to determine the level of development of students' cognitive soft skills. A total of 120 students from the control group and 118 students from the experimental group participated in the post-test (Table 4).

Table 4

Comparison of the Post-Test Results of the Experimental and Control Groups

Group	N	M	Mdn	SD	SE	t	df	p
CG	120	11.50	11.50	2.89	0.264	9.01	236	<.001
EG	118	14.40	14.40	2.03	0.187	—	—	—

Note. CG = control group; EG = experimental group; M = mean; Mdn = median; SD = standard deviation; SE = standard error. The independent-samples *t* test showed a statistically significant difference between the groups at the post-test stage, $t(236) = 9.01$, $p < .001$.

According to the descriptive statistics, the control group had a mean score of ($M = 11.5$) ($SD = 2.89$), whereas the experimental group had a mean score of ($M = 14.4$) ($SD = 2.03$). The median values were 11.5 and 14.4, respectively, indicating substantially higher performance in the experimental group. The standard errors were ($SE = 0.264$) for the control group and ($SE = 0.187$) for the experimental group, confirming the stability of the data. An independent-samples *t*-test was conducted to determine whether the post-test results differed significantly between the control and experimental groups. The analysis yielded ($t = 9.01$), ($df = 236$), and ($p < .001$). This result indicates that the difference between the two groups was highly statistically significant. The post-test findings demonstrated that the cognitive soft skills of students in the experimental group developed to a considerably higher level than those of students in the control group. Compared with the pre-test results, the control group showed only minor changes, whereas the experimental group showed a clear positive trend. These findings provide scientific evidence of the high effectiveness of the implemented pedagogical methods in developing students' cognitive soft skills.

Discussion. The questionnaire findings showed that students demonstrated above-average levels of communication, teamwork, self-management, and learning motivation. These results indicate that soft skills are interconnected personal and social competencies that schools can purposefully support within the learning environment. This finding aligns with the contemporary meta-analysis by Cipriano et al. (2023), which synthesized 424 studies involving students from kindergarten through Grade 12 and showed that systematically organized school-based social and emotional learning interventions can improve students' skills, attitudes, peer relationships, school functioning, and academic outcomes. In this respect, the present findings extend previous evidence by demonstrating that an integrative approach can simultaneously address communication, collaboration, self-management, and learning motivation within general education institutions (Cipriano et

al., 2023). The test results further supported the effectiveness of the integrative model in developing students' cognitive soft skills. The lack of a statistically significant difference between the experimental and control groups at the pre-test stage indicated comparable baseline performance, while the significantly higher post-test scores of the experimental group showed positive changes following the intervention. Similar effects have been reported in studies emphasizing collaborative and technology-supported learning. Wei et al. (2025) found that integrating generative artificial intelligence into collaborative activities supported collaborative problem-solving and team creativity, while Chaiyarat (2024) showed that structured cooperative learning activities significantly enhanced seventh-grade students' creative problem-solving and learning motivation. Taken together, these findings support the view that cognitive soft skills develop more effectively when learners actively participate in structured, collaborative, and problem-oriented learning activities rather than receiving knowledge passively (Chaiyarat, 2024; Wei et al., 2025).

The positive development of self-management and learning motivation observed in the present study is also consistent with recent research on self-regulation and learner autonomy. The meta-analysis by Mammadov and Schroeder (2023), which synthesized 153 studies, showed that autonomy-supportive educational environments were positively associated with autonomous motivation, behavioral engagement, self-regulated learning, and students' self-beliefs across different educational levels. Similarly, Xu et al. (2023) showed that self-regulated learning strategies are closely associated with academic achievement, particularly when learners receive structured support in technology-enhanced learning environments. The present study therefore suggests that the effectiveness of the integrative model may be related not only to the development of specific interpersonal skills but also to the creation of learning conditions that encourage students to take responsibility for their learning, regulate their activities, and participate more actively in educational tasks (Mammadov & Schroeder, 2023; Xu et al., 2023).

The qualitative findings obtained through interviews and pedagogical observations complemented the quantitative results. Students in the experimental group reported greater engagement in learning, increased interest in group and project-based activities, and greater confidence in expressing their ideas. These results are consistent with Zahn et al. (2025), who identified communication, collaboration, problem-solving, and related interpersonal competencies as central themes in contemporary soft skills research. Luengo-Aravena et al. (2024) also support this view, emphasizing the close relationship between digital skills and students' ability to participate effectively in collaborative problem-solving activities. The convergence of questionnaire, test, observation, and interview findings in the present study strengthens the interpretation that soft skills develop most effectively in learning environments that give students repeated opportunities for interaction, collaboration, problem-solving, and active participation (Luengo-Aravena et al., 2024; Zahn et al., 2025).

Another important finding is that the study did not treat soft skills development as an isolated extracurricular activity; it integrated it into the broader teaching and learning process. The model combined classroom activities with teacher professional support, collaborative pedagogical practices, parental involvement, and systematic assessment. This multidimensional approach aligns with evidence showing that the effectiveness of school-based interventions depends not only on individual learning activities but also on implementation quality and the educational context in which they are embedded. Cipriano et al. (2023) showed that intervention characteristics, implementation quality, and contextual factors significantly influence outcomes of school-based social and emotional learning programs, while Mammadov and Schroeder (2023) demonstrated the importance of both teacher and parent support for positive student outcomes. Thus, the present findings emphasize the value of coordinating school, teacher, learner, and family-level support when developing soft skills in general education (Cipriano et al., 2023; Mammadov & Schroeder, 2023).

Overall, the results indicate that the integrative model can support the development of students' social, personal, and cognitive soft skills by combining structured pedagogical activities, collaborative learning, teacher support, parental involvement, and systematic assessment. At the same time, the findings should be interpreted within the context of the participating schools in Turkistan. Further research involving schools from different regions, larger and more diverse student populations, and longer intervention periods would help determine the generalizability and sustainability of the observed effects. Longitudinal studies could also examine whether improvements in communication, teamwork, self-management, motivation, and cognitive soft skills are maintained over time and transferred to other academic and social contexts (Cipriano et al., 2023; Xu et al., 2023).

Conclusion. The study showed that the integrative model for soft skills development effectively improved students' communication, teamwork, self-management, learning motivation, and cognitive soft skills in general education institutions. The experimental group showed significantly better post-test results than the control group, confirming the effectiveness of the implemented pedagogical intervention. The study's main contribution is the development and empirical validation of an integrative model that combines instructional content, pedagogical methods, teacher professional support, parental involvement, and systematic assessment of soft skills within the school learning process. The model provides a structured approach for integrating soft skills development into general education rather than treating these skills as an additional or separate component. The findings offer a practical framework that can support educational practice and teacher professional development. Future studies may examine the model's effectiveness in different educational contexts and with larger, more diverse student populations.

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Developing the Research Skills of Future Primary School Teachers through STEM: An Empirical Evaluation

Abstract

Introduction. Pre-service primary school teachers are expected to work with evidence, classroom problems, and small-scale inquiries, rather than relying solely on ready-made pedagogical knowledge. The present study examines how a voluntary extracurricular program grounded in science, technology, engineering, and mathematics (STEM) supports the development of research skills among prospective primary school teachers. *Materials and Methods.* The study used a quasi-experimental pre-test and post-test design. The program took place outside regular classroom hours and included inquiry-oriented tasks, project work, collaborative problem-solving, evidence analysis, presentation of findings, and guided reflection. The assessment of students' research skills used an adapted questionnaire focused on critical thinking, the application of research methods, and reflection. *Results.* The findings demonstrated positive changes in students' general research skills and in the main components of research activity. *Scientific novelty.* The study shows that science, technology, engineering, and mathematics can serve not only as interdisciplinary learning tools but also as a pedagogical environment for building a research culture in teacher education. *Practical significance.* The proposed program could help teacher education institutions improve students' preparedness for inquiry-based and project-oriented professional practice.

Keywords: STEM technology, pre-service primary school teachers, research skills, quasi-experiment, pre-test and post-test, reflection.

Introduction. The contemporary era is transitioning from the “information age” to the “age of synthesis,” a shift that requires integrating knowledge from diverse scientific and practical domains (Nadelson & Seifert, 2017). This process has increased demand for individuals in the labor market who can quickly assimilate scientific and technological advancements, demonstrate advanced cognitive abilities, and address complex challenges (Hebebcı & Usta, 2022). Consequently, the conventional educational framework is undergoing a transition towards dynamic learning methodologies designed to cultivate 21st-century competencies within the context of the Sustainable Development Goals (Rehman

et al., 2025). These changes necessitate adjustments and a fundamental rethinking not only of the curriculum context but also of teachers' professional roles. In this context, the STEM (science, technology, engineering, and mathematics) education model has gained widespread recognition as an effective approach to fostering critical thinking, scientific creativity, and problem-solving skills (Hebebcı & Usta, 2022; Nguyen et al., 2020).

The STEM approach is not confined to knowledge integration; it focuses on organizing inquiry-based learning activities to enhance students' cognitive engagement. Nevertheless, STEM education's potential largely focuses on students, with limited attention to the research

training of the teachers who implement it. Recent studies demonstrate that preparing future primary and elementary school teachers for integrated science, technology, engineering, and mathematics (STEM) education remains an important yet underdeveloped area of teacher education. Many pre-service elementary teachers lack confidence in teaching integrated STEM (Menon et al., 2023; Wieselmann et al., 2025).

These individuals tend to rely on short-term course experiences, lesson-planning tasks, and opportunities to observe or practice integrated instruction. Research on primary pre-service teachers further indicates that practical experiences, such as makerspace activities, inquiry-based tasks, and engineering design practices, can strengthen their confidence, attitudes, and readiness for interdisciplinary teaching (Halliburton et al., 2024; Lupión-Cobos et al., 2026). These findings emphasize the need to examine not only students' learning outcomes but also the research-oriented preparation of future teachers expected to design, implement, and evaluate integrated learning activities. Teachers' professional development programs must foster a growth mindset, encourage critical reflection on practice, and support evidence-based pedagogical decision-making (Milner-Bolotin, 2018; Vossen et al., 2020). These requirements underscore the significance of intentionally cultivating a research culture during the initial stage of teacher education. Nevertheless, existing research suggests that prospective teachers lack awareness of STEM education programs. For instance, as Anisimova et al. (2020) demonstrate, only 18% of students exhibit adequate comprehension of the STEM context, while only 10% report feeling prepared to organize project-based research activities (Anisimova et al., 2020).

Despite the evident enthusiasm among prospective primary school teachers for STEM subjects, their grasp of multidisciplinary and practical research skills remains limited. This suggests a gap in STEM education development, particularly in teacher training programs, where the STEM approach remains predominantly theoretical. Prospective educators need to

develop a research culture systematically. First, STEM is intended as a formal integration of subjects; however, teachers do not fully use their research skills and multidisciplinary potential (El Nagdi et al., 2018; Nadelson & Seifert, 2017). Second, teacher education programs often teach research and design activities in isolation. This hinders future teachers' ability to apply scientific knowledge to solve authentic pedagogical problems (Vossen et al., 2020). Third, many teachers struggle to integrate engineering and technological elements into their lessons (extrinsic challenges), which is linked to insufficient interdisciplinary knowledge (Dong et al., 2020). Empirical studies examining the impact of STEM technologies on the research competence of future primary school teachers remain limited. In this regard, investigating the effectiveness of STEM-based courses in developing the research skills of future primary school teachers is a relevant problem.

Contemporary scientific literature conceptualizes STEM education (science, technology, engineering, and mathematics) not only as the integration of knowledge but also as a pedagogical approach that employs inquiry- and design-based activities to solve real-world problems. Research undertaken within the domain of early education has indicated that STEM-based teaching sequences, which are oriented towards the development of students' inquiry skills – encompassing the formulation of questions, the generation of hypotheses, observation, practice, the collection of data, and evidence-based reasoning (Rúa Martínez et al., 2024) – are conducive to this process. Systematic reviews of STEAM practices at the primary school level support this direction. STEAM/STEM interventions have been shown to enhance students' learning engagement, knowledge, and skills (Yim et al., 2025). However, the effectiveness of these interventions is contingent on developing teachers' methodological preparedness and providing sustained professional support. Consequently, the efficacy of STEM education depends not solely on the "individual method" but largely on educators' systemic professional competence and the affordances of their

learning environments. Research skills at the primary school level are a complex competence that develops progressively, from initial curiosity to purposeful questioning, information gathering, data collection, analysis, and drawing conclusions. Pedagogues have observed that research skills do not develop spontaneously; rather, lesson effectiveness improves when teachers implement well-organized tasks, provide guiding questions, and offer systematic feedback (Aktepe & Ulu, 2023).

This finding emphasizes the critical role of pedagogical design and the teacher's facilitative function in fostering a research-oriented culture. Recent literature has increasingly emphasized that science, technology, engineering, and mathematics education in teacher preparation should be organized around active inquiry, design-based tasks, collaboration, and reflection. Research on design-based science, technology, engineering, and mathematics (STEM) activities indicates that such tasks can cultivate preservice teachers' design thinking, problem formulation, solution testing, and evaluation skills (Yüksel, 2025).

In a similar vein, studies examining integrated science, technology, engineering, and mathematics education in primary and elementary settings have underscored the significance of authentic problems, interdisciplinary connections, teacher facilitation, and structured learning environments (Cheek et al., 2025; Rúa Martínez et al., 2024; Yim et al., 2025). From this standpoint, cultivating research aptitudes among prospective primary school educators is integral to comprehensive professional preparation, since inquiry, evidence analysis, methodological selection, and reflection are pivotal to both research endeavors and integrated science, technology, engineering, and mathematics pedagogy. In teacher training, several studies have shown that introducing STEM inquiry-based learning in short-term programs is ineffective.

The creation of a robust foundation of interdisciplinary learning designs, research project cycles, and evaluation tools at the primary school level requires long-term preparation (Yim et al., 2025). Research undertaken within the Kazakhstani context

demonstrates that the implementation of STEM education is influenced by institutional and social factors, underscoring the substantial interconnections between teacher agency and classroom practice. This underscores the need to consider local contextual conditions when evaluating the effectiveness of STEM-based interventions (Durrani & Kataeva, 2025). The extant literature consistently emphasizes the potential of STEM/STEAM approaches to foster inquiry skills in primary education (Rúa Martínez et al., 2024; Yim et al., 2025). Similarly, Tolkynbayeva et al. (2026) found that systematically integrating STEM-based inquiry tasks supports the development of research skills, including hypothesis formulation, data analysis, problem-solving, and project-based investigation. However, empirical studies in post-Soviet contexts such as Kazakhstan examining the effectiveness of semester-long STEM-based interventions to develop inquiry skills among future primary school teachers, using a pre-test/post-test design, remain limited (Durrani & Kataeva, 2025). In response to this gap, the present study seeks to empirically assess the impact of a STEM technology-based course on the development of inquiry skills among future primary school teachers, including its core components: critical thinking, application of research methods, and reflection (Aktepe & Ulu, 2023; Yim et al., 2025).

This study aims to determine the impact of STEM-technology-based courses on the research skills of future primary school teachers. To achieve this objective, the study seeks to develop technological and pedagogical knowledge by employing the method "Model - Reflection - Research-Practice" (Milner-Bolotin, 2018), enhance their self-efficacy in research activities by fostering a personal pedagogical philosophy aligned with STEM, and evaluate the effectiveness of integrating research and design cycles within Professional Learning Communities (Vossen et al., 2020).

In accordance with the purpose of this study, the following research questions were formulated:

1. Does a voluntary extracurricular program based on science, technology, engineering, and

mathematics have a statistically significant effect on the overall level of research skills of future primary school teachers?

2. Which components of research skills show the most evident changes after the intervention: critical thinking, application of research methods, or reflection?

3. How are students' research skills reflected in their learning products and reflective notes during the program?

Materials and Methods. Research Design. The study used a quasi-experimental one-group pretest/posttest design. This design was selected to examine changes in future primary school teachers' research skills before and after participation in a voluntary extracurricular program grounded in science, technology, engineering, and mathematics. The pre-test was administered before the intervention, and the post-test after the program's completion. Comparing the two measurements enabled identification of changes in students' research skills following the intervention.

Research Model. The intervention was organized as a voluntary extracurricular program to develop students' research skills through inquiry-oriented and project-based activities. The program was conducted outside standard classroom hours and was not mandatory. The program focused on the key phases of research, including identifying research problems, formulating research questions, selecting appropriate methods, collecting data, analyzing evidence, developing arguments, presenting results, and reflecting. Students completed individual and group assignments related to pedagogical scenarios and small-scale research issues. The collaborative learning approach entailed group discussions, role distribution, joint decision-making, and the presentation of findings. The program helped students engage with research not only as theoretical knowledge but also as a series of practical actions linked to future teaching practice.

Participants. The participants were undergraduate students majoring in Primary Education Pedagogy and Methodology. The study comprised 26 students. Participation in the extracurricular program was voluntary. Prior

to the commencement of the intervention, the study objective was explained to the students. The subjects were informed that the collected data would be used solely for research purposes and kept confidential.

Data Collection Tools. The primary data collection instrument was a 25-item questionnaire designed to evaluate students' research aptitudes. The questionnaire was adapted from the research skills instrument presented in "Development and Validation of Research Skills Instruments for Pre-service Biology Teachers". The items were reformulated to align with the academic and professional contexts of future primary school teachers while preserving the original instrument's core logic. The questionnaire encompassed three components of research skills: critical thinking, the application of research methods, and reflective skills. Responses were evaluated using a five-point Likert scale.

Data Collection Process. Data was collected in two stages during the voluntary extracurricular intervention. In the first stage, students completed the questionnaire before the program began. The intervention was then implemented outside regular classroom hours through inquiry-oriented tasks, project work, collaborative activities, evidence analysis, presentation of findings, and guided reflection. In the second stage, the same questionnaire was administered after the program. During the intervention, students produced learning materials such as project plans, short reports, task outcomes, presentations, and reflective notes. These materials helped clarify how students engaged with research-oriented tasks and applied research skills in practical educational situations.

Ethical Consideration. The study followed the ethical principles of the Declaration of Helsinki and relevant national regulations on research involving human participants. The research was limited to a non-interventional educational program and an anonymous questionnaire survey of adult university students; it involved no medical, clinical, or biomedical procedures, no deception, and no collection of sensitive personal data. Under the institutional regulations

in force, studies of this type do not require review by a formal ethics committee.

Participation in both the extracurricular program and the survey was entirely voluntary. Before the intervention began, students were informed of the study's aims, the procedures involved, and that the data would be used for research purposes only, and they gave informed consent to participate. They were advised that they could decline to take part or withdraw at any stage without giving reasons, and that neither participation nor withdrawal would affect their academic assessment or their relationship with the teaching staff. No incentives were offered.

Questionnaire responses were coded numerically without names or other identifiers; the codes linking pre-test and post-test responses were held separately and destroyed once the data had been matched. Students' learning products and reflective notes were analyzed in anonymized form, and all data are reported exclusively in aggregated form, without details that would permit the identification of individual participants.

Data Analysis. Quantitative data was processed using statistical software. First, we calculated descriptive statistics, including mean

and standard deviation, for the overall research skills score and each component. The normality of the data was then checked. To compare pre-test and post-test results, a paired-samples t-test was applied. The magnitude of the intervention effect was determined using Cohen's *d*. Students' learning products and reflective notes were analyzed descriptively to support the interpretation of the quantitative findings.

Results. The study compared the overall level of research skills among future primary school teachers using pre- and post-test results. The findings indicated that students' overall research skills improved substantially after the training intervention. Before the intervention, the average general research skills score was 41.12 (SD = 4.56). However, following the intervention, this score increased to 53.38 (SD = 5.21) (Table 1). The difference between the means indicates that students acquired more research skills through the learning process. The approximate standard deviation values indicate that the indicators within the group are relatively uniform. The findings of this study provide compelling evidence that the training intervention positively impacted the development of research skills among future teachers.

Table 1

Descriptive statistics for pre-test and post-test scores (n=26)

		Descriptive Statistics			
	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test	26	33	52	41.12	4.555
Post-test	26	45	67	53.38	5.208

We examined data normality using the Kolmogorov–Smirnov test. For most variables, no statistically significant deviations were detected ($p > 0.05$), indicating that the data could be assumed to be approximately normally distributed. Accordingly, a paired-samples t-test was applied as a parametric method to compare pre-test and post-test results. The paired t-test was used to determine the statistical significance of the differences between pre-test and post-test scores. The analysis showed a statistically significant difference between pre-test and post-test results for the overall level of research skills.

The mean difference between pre-test and post-test scores was -12.27 points, indicating that post-test scores were higher than pre-test scores. The 95% confidence interval for the mean difference ranged from -13.37 to -11.17 and did not include zero, demonstrating the stability and reliability of the obtained results. The paired t-test revealed a highly significant difference between the two measurements ($t(25) = -22.99$, $p < .001$) (Table 2). These findings indicate that the instructional intervention had a clear and systematic effect on improving the overall research skills of future primary school teachers.

Table 2

Paired t-criterion results for comparing pre-test and post-test results by General research skill level (n=26)

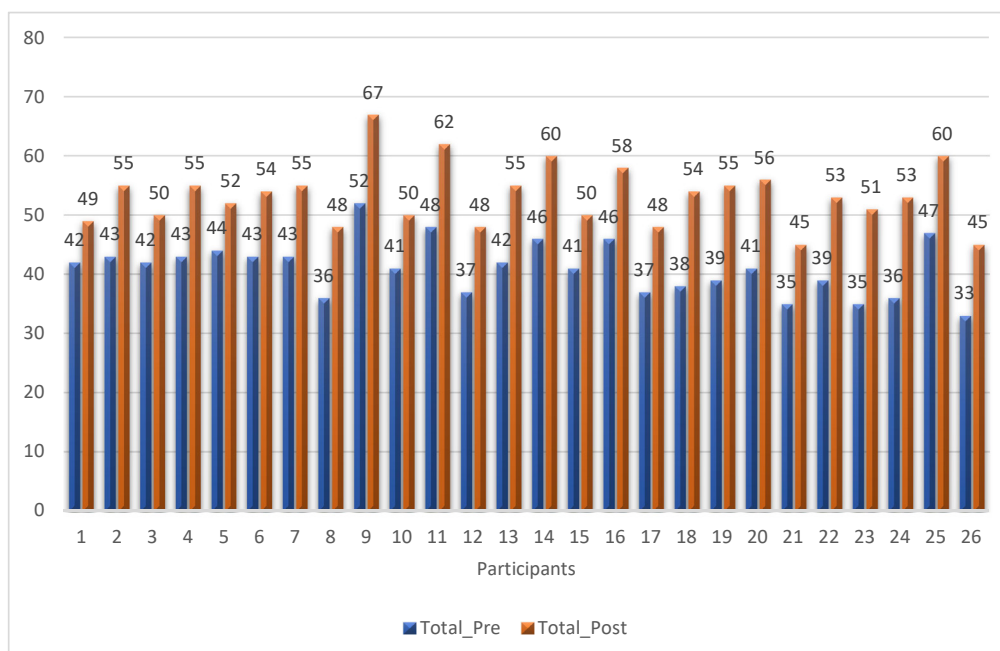
Paired Samples Test									
Paired Differences						t	df	Significance	
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				One- Sided p	Two- Sided p
				Lower	Upper				
Total_Pre - Total_Post	-12.269	2.721	.534	-13.368	-11.170	-22.991	25	<.001	<.001

Figure 1 presents the pre-test and post-test results for the overall research skills of future primary school teachers, displayed individually for each participant. The graph clearly shows that post-test scores are higher than pre-test scores for nearly all participants. While pre-test scores were mainly clustered between 33 and 52 points, post-test scores increased to a range of 45–67 points. These results show that, following the instructional intervention,

research skills improved not only in terms of mean values but also consistently at the level of individual participants. Although the magnitude of improvement was more pronounced for some participants and relatively smaller for others, the overall trend across all participants is clearly positive. This pattern suggests the intervention's effect was stable and consistent despite individual differences.

Figure 1

Comparison of Pre-test and Post-test results by individual participants



The analysis conducted across the components of research skills also revealed positive dynamics in all dimensions. For the critical thinking component, the mean score at

the pre-test stage was 14.08 (SD = 2.40), which increased to 18.04 (SD = 3.22) at the post-test stage. This indicates improved students' ability to analyze information, evaluate evidence, and

make well-reasoned decisions. A clear increase was also observed in the component related to applying research methods. The mean pre-test score was 16.23 (SD = 2.94), while the post-test score rose to 21.12 (SD = 3.46). These results suggest that future teachers developed a stronger understanding of research methods and a greater capacity to apply them in their learning. The reflection component also showed positive changes. The mean score increased from 10.81 (SD = 2.70) at the pre-test stage to 14.23 (SD = 3.01) at the post-test stage, indicating greater ability to analyze one's own learning activities, evaluate outcomes, and assume responsibility for professional development. Overall, the

component-level results show stable, systematic gains across all core dimensions of research skills. The analysis confirmed that differences were statistically significant not only for the overall research skills score but also for each component ($p < .001$). In particular, post-test results for critical thinking, application of research methods, and reflection were substantially higher than pre-test scores, confirming that these changes were not random (Table 3). Taken together, the findings provide evidence that the implemented instructional program had a meaningful effect, not only statistically but also pedagogically, in fostering the research skills of future primary school teachers.

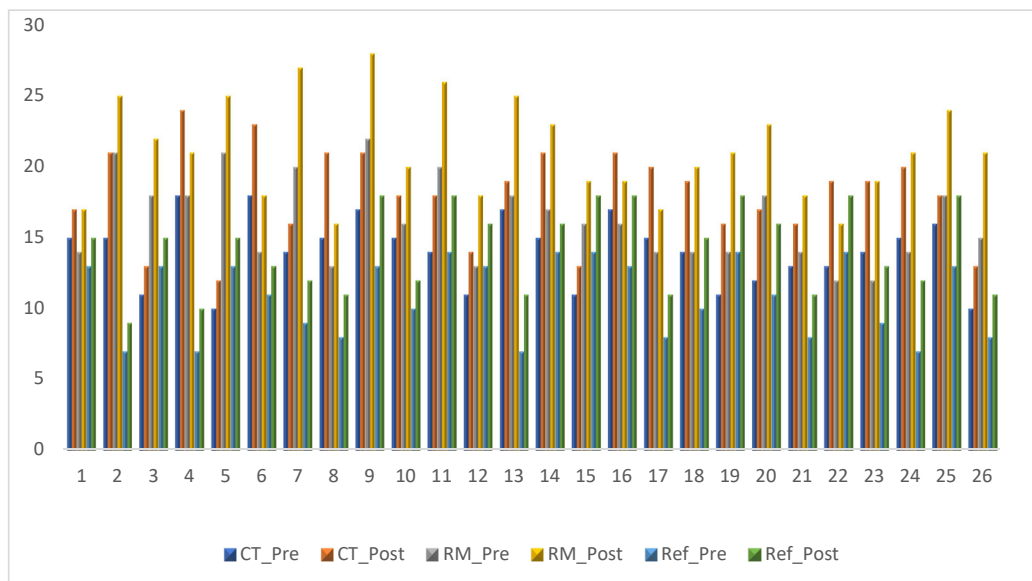
Table 3

Results of Paired Samples T-Tests Comparing Pre-test and Post-test Scores across Research (Skill Components)

Paired Samples Test									
Paired Differences						t	df	Significance	
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				One- Sided p	Two- Sided p
				Lower	Upper				
Critical thinking	-3.962	1.536	.301	-4.582	-3.341	-13.153	25	<.001	<.001
Application of research method	-4.885	1.505	.295	-5.493	-4.277	-16.545	25	<.001	<.001
Reflection	-3.423	1.137	.223	-3.883	-2.964	-15.345	25	<.001	<.001

Figure 2 shows changes in pre-test and post-test results at the level of individual participants in the main components of the research skills of future primary school teachers: critical thinking, application of research methods, and reflection. The graph shows that post-test indicators for all components are higher than the pre-test results. Growth is especially pronounced in the use of research methods component, indicating an increase in students'

ability to master research approaches and apply them in the educational process. In the critical thinking and reflection components, results also show a steady upward trend during the post-test period. Although indicators fluctuate among individual participants, the overall trend remains positive across all components. These graphs visually confirm the effectiveness of the training intervention in all key components of research skills.

Figure 2*Dynamics of pre-test and post-test results on research skills components*

Note. CT = critical thinking; RM = application of research methods; Ref = reflection

Discussion. This study aimed to evaluate the impact of a semester-long STEM technology-based course on the research skills of future primary school teachers. The results showed a clear increase in overall research skills after the intervention: pre-test period $M = 41.12$ ($SD = 4.56$), post-test period $M = 53.38$ ($SD = 5.21$). A paired-samples t-test confirmed that this difference was statistically significant ($t(25) = -22.99$, $p < .001$, 95% CI $[-13.37; -11.17]$). Component-level analysis revealed a consistent pattern of positive change across all dimensions. Statistically significant improvements were observed in critical thinking ($t(25) = -13.15$, $p < .001$), application of research methods ($t(25) = -16.55$, $p < .001$) and reflection ($t(25) = -15.35$, $p < .001$). Thus, the findings demonstrate that upon completion of the course, the cognitive (critical thinking), instrumental (use of research methods), and metacognitive (reflection) components of students' research skills developed simultaneously. Compared with previous studies, much of the existing literature characterizes the effectiveness of STEM interventions primarily through student-level learning outcomes, such as problem-solving ability, critical thinking, scientific creativity, and increased interest in learning (Hebebe & Usta,

2022; Ortiz-Revilla et al., 2020). In this respect, the present findings extend existing evidence by demonstrating that the potential of the STEM approach is not limited to learners alone but also applies to the professional preparation of future teachers, particularly in relation to their research skills. This aligns with the logic of research-oriented learning discussed by Ceylan (2014), as research activity itself unfolds through stages of problem identification, hypothesis formulation, evidence collection, and conclusion drawing (Ceylan, 2014).

At the same time, several studies have reported weak or non-significant effects of STEM interventions, often attributing these outcomes to the short duration of the intervention (Değerli & Yapıcı, 2022). In the present study, the systematic organization of the intervention over an entire semester may be a key factor underlying the observed gains. The extended timeframe, combined with repeated learning cycles, likely created favorable conditions for consolidating research skills. To better understand the mechanisms behind these results, it is important to consider the course's instructional logic. STEM technologies shift learning from passive information reception to active inquiry and knowledge construction,

encouraging learners to formulate research questions, work with data, and justify their solutions (Dong et al., 2020). This effect is particularly pronounced in design-based learning contexts, where learners identify a problem, develop or test a prototype or solution, and refine outcomes through iterative cycles (Nguyen et al., 2020).

Moreover, the interconnection between research and design plays a critical role: research informs design decisions, while design activities generate new research questions. This integration strengthens future teachers' ability to connect scientific knowledge with pedagogical tasks (Vossen et al., 2020). The parallel improvement observed across all research skill components supports this interpretation. Students demonstrated not only improved data collection abilities, but also greater capacity for critical evaluation and evidence-based reasoning (Daryanes et al., 2025). The positive dynamics observed in the reflection component further suggest that the metacognitive core of research culture - self-evaluation, error recognition, and planning subsequent steps - can be effectively fostered through structured instructional tasks (Milner-Bolotin, 2018).

Additional factors may also help explain the findings in the context of future primary school teachers. Previous research indicates that while pre-service teachers often express strong interest in STEM, they struggle to establish interdisciplinary connections and translate research-design cycles into concrete lesson plans. Students in teacher education programs also tend to feel more confident in mathematical components, while reporting lower preparedness when integrating natural sciences and technology elements (Kurup et al., 2019). In such contexts, structured approaches such as "Modeling-Reflection-Research-Practice" may support the gradual mastery of complex activities and enhance students' sense of self-efficacy (Milner-Bolotin, 2018). Furthermore, social factors, including gender stereotypes, may indirectly influence motivation to engage with STEM fields. Therefore, interpreting the results through the lens of professional beliefs and cultural context is both relevant and necessary

(Durrani & Kataeva, 2025). From a practical perspective, the results highlight the importance of planning STEM-based courses in teacher education institutions in a systematic, long-term format to support the development of research skills. Such courses can be effective when they move beyond theoretical introductions and consistently incorporate problem formulation based on authentic pedagogical situations, small-scale research tasks, project work, presentation and defense of results, and reflective analysis. However, because teachers frequently cite time constraints for lesson planning and material preparation as significant barriers, future implementations should address methodological support and resource provision alongside curriculum design (Margot & Kettler, 2019).

The limitations of this study must be shown at the analysis interpretation stage. First, the use of a single-group pre-test/post-test design without a control group increases threats to internal validity, as the observed improvements may also be influenced by testing effects or time-related factors. Second, the small sample size ($N = 26$) and the focus on a single institutional context limit the generalizability of the findings. Third, as the primary measurement instrument relied on self-report data, the possibility of socially desirable responses cannot be excluded. Future studies would benefit from triangulation through rubric-based assessment of student products (e.g., project plans, reports, presentations), classroom observations, and expert evaluations. Fourth, the absence of follow-up measurements does not allow conclusions about the long-term sustainability of the observed effects. Given these limitations, future research using quasi-experimental designs with control groups, multi-site samples, and longitudinal follow-up measures would strengthen conclusions about the effectiveness of STEM-based interventions. Overall, the study shows that a semester-long STEM technology-based course leads to statistically significant positive changes in the research skills of future primary school teachers across all major components. These findings underscore the potential of the STEM approach as a purposeful tool for cultivating research

culture within teacher education, while also highlighting the need for further research using more robust designs to reinforce the evidence base.

Conclusion. The present study demonstrated that a voluntary extracurricular program grounded in science, technology, engineering, and mathematics can support the development of research skills among future primary school teachers. The program facilitated student engagement with the fundamental stages of inquiry, including identifying educational problems, formulating research questions, selecting appropriate methods, analyzing evidence, presenting findings, and reflecting on learning decisions. The findings suggest that students' research capabilities have improved not only in overall proficiency but also across the primary components of research activity: critical thinking, the application of research methods, and reflection.

The primary contribution of this study is that it presents science, technology, engineering, and mathematics as more than an interdisciplinary

teaching approach. In teacher education, it can serve as a practical pedagogical environment that cultivates an inquiry culture, evidence-based thinking, and reflective professional action. This is particularly significant for prospective primary school teachers, as their professional preparation should encompass not only subject and methodological expertise, but also the capacity to analyze classroom issues through a research-oriented lens.

The study also posits that research skills develop more effectively when students engage in practical, collaborative, and reflective tasks rather than when research is taught solely as a theoretical requirement. The findings may be of use to teacher education programs seeking to strengthen students' readiness for inquiry-based and project-oriented professional practice. Subsequent studies may extend this research by utilizing larger samples, incorporating control groups, and implementing delayed follow-up measurements to assess the longevity of the observed alterations.

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Development of an Inclusive Education Ecosystem Based on the Adapted Future Classroom Lab Model

Abstract

Introduction: The article discusses the problem of forming an effective inclusive education ecosystem in the system of training future teachers. The study aims to scientifically substantiate the potential to develop future teachers' inclusive competencies by adapting the Future Classroom Lab (FCL) model to the conditions of higher pedagogical education. **Methodology and Methods.** The study's methodological framework draws on mixed-methods research design, providing a broad and nuanced understanding of the inclusive education ecosystem. **Results.** The study found that implementing the FCL model enables inclusive education to be organized not as a set of individual methods, but as a holistic ecosystem whose pedagogical, spatial, and technological components are interconnected. Future teachers have systematically developed their skills in diagnostic and evaluative, didactic adaptation, and inclusive assessment. TEIP results in quantitative indicators increased significantly: confidence in inclusive education rose from 2.8 to 3.9, task adaptation from 2.6 to 3.8, and behavior management from 2.7 to 3.7. Class indicators also improved (emotional support, process organization, and cognitive stimulation). According to SACERS, the overall average assessment of the learning environment was high, ensuring the availability and safety of premises, flexibility of zones, and inclusive adaptation. **Scientific novelty.** The study's scientific novelty lies in adapting the Future Classroom Lab model to the context of higher pedagogical education and justifying inclusive training at the university-future-teacher level using an ecosystem approach - **practical significance.** The results provide a clear methodological basis for training future teachers in universities to work in an inclusive environment based on experience. The FCL ecosystem allows for the reorganization of the learning space, the development of adapted educational materials, the creation of a safe psychosocial environment, and the implementation of inclusive approaches to assessment.

Keywords: inclusive education, future classroom lab, inclusive ecosystem, pedagogical competence, blended methodology, learning environment, inclusive competence.

Introduction. Today, the global educational landscape is changing rapidly. Accelerating social processes, technological advancements, and economic transformations have placed new demands on the education system. In the ever-changing, uncertain, complex, and ambiguous VUCA world, education must no longer be limited to the transmission of knowledge and skills. Instead, it must evolve as a flexible, open, and sustainable ecosystem that empowers individuals to reach their full potential. As part of these changes, it is especially important to consider the interests of students with special

educational needs. Ensuring their equal access to quality education has become one of the main strategic priorities in education.

The development of inclusive education in the Republic of Kazakhstan has been identified as one of the most important areas of state policy. This position is directly linked to the country's long-term development goals. In his Address "Economic Guidelines for a Just Kazakhstan" (2023), President Kassym-Jomart Tokayev emphasized that inclusivity and justice are the foundation for sustainable social development. (Tokayev, 2023).

This approach aims to ensure that every child, including those with special educational needs, has the right to receive a safe, accessible, and high-quality education. From this perspective, implementing the national project “Comfortable School” (2022) (Government of the Republic of Kazakhstan, 2022), developing a digital educational environment, and improving the professional quality of teaching staff are closely interconnected and complementary tasks. However, the difficulties in implementing inclusive education are not limited to a lack of material and technical resources. In fact, the main challenge is that future teachers are not adequately prepared to work in an inclusive environment. In today’s universities, the teacher training process remains insufficient, focusing on experience-based education that often prioritizes theory and lacks specific inclusive conditions.

As a result, young professionals face serious difficulties working with students with different educational levels and psychophysiological characteristics when they enter school. Today’s teacher is not only a specialist who is well-versed in their subject matter. They must also be a professional who can identify each student’s individual needs in the classroom, adapt learning tasks accordingly, use flexible assessment approaches, and make effective use of digital technologies. These requirements call for a new approach to training future teachers. Therefore, introducing modern approaches and practice-oriented, innovative models in teacher training has become urgent. In this regard, the adaptive implementation of the Future Classroom Lab (FCL) model in higher education is particularly important as an effective way to create an inclusive education ecosystem. Developed by the European Schoolnet initiative, this model offers a fresh perspective on the educational landscape. (European Schoolnet, 2012). The FCL concept views the classroom not just as a technology-equipped room, but as a flexible, multifunctional environment with interconnected areas for research, creation, presenting ideas, building relationships, sharing experiences, and reflection. This educational space provides a real opportunity for the

comprehensive development of professional, social, and digital competencies for future teachers.

This research is relevant to the need to implement innovative best practices in education, as outlined in the Law of the Republic of Kazakhstan on Education (Law of the Republic of Kazakhstan, 2007). In particular, Article 43-1 of the law clearly states the importance of modern approaches aimed at modernizing the education system. At the same time, this issue relates to the task of creating a digital pedagogical environment, as outlined in the Concept for the Development of Higher Education and Science in the Republic of Kazakhstan for 2023–2029 (Government of the Republic of Kazakhstan, 2023).

The article explores the importance of Future Classroom Lab zones in developing soft skills for future teachers. It also analyzes the application of the SACERS and CLASS scales for assessing the quality of the educational environment, as well as the methodological aspects of using digital technologies in inclusive education. The research results will serve as a basis for developing a modern model of training inclusive teachers. They will make a real contribution to the modernization of the higher education system for teachers.

The Future Classroom Lab (FCL) concept, developed by the European Schoolnet in 2012, has become one of the most influential models for transforming educational environments in response to the demands of 21st-century learning. The model emphasizes flexible learning spaces, digital technologies, active pedagogies, and student-centered instruction. According to a systematic review by Pablo Dúo-Terrón (2024), research on FCL demonstrates its positive impact on learner engagement, collaboration, digital competence development, and innovative teaching practices. The author highlights that the FCL framework promotes reorganizing educational spaces into interconnected learning zones that support creativity, inquiry, interaction, and the presentation of knowledge. Related research on innovative learning environments also highlights the effects of classroom design on learning (Barrett et al., 2015), differences

between traditional and innovative environments (Byers et al., 2018a, 2018b), transition strategies (French et al., 2020), the design of a Future Classroom Laboratory (Colton et al., 2020), and the use of FCL-based active and gamified learning (Montero-Izquierdo et al., 2024). Studies of 21st-century classrooms further emphasize changes in learning and teaching practices (Göçen et al., 2022).

A growing body of research suggests that contemporary educational institutions should be viewed as learning ecosystems (Yang, C., Wang, T., & Xiu, Q., 2025) rather than isolated classrooms. Learning ecosystems integrate pedagogical, technological, social, and organizational components into a unified educational environment. Recent studies emphasize that effective educational ecosystems facilitate personalized learning, collaboration among stakeholders, and equitable access to educational resources. Such ecosystems are particularly important in the context of inclusion because they enable the participation of diverse learners with different educational needs. Research on inclusive innovative learning environments further emphasizes inclusive practice and belonging for students with disabilities (Page et al., 2021a, 2021b, 2023, 2024), psychological safety in innovative spaces (Charteris et al., 2024), and the challenges of creating inclusive learning environments in higher education (Korthals Altes et al., 2024). Evidence from Scotland also demonstrates the importance of space in supporting pupils with additional support needs (Clemson & Coyle, 2025).

The development of an inclusive educational ecosystem requires not only technological innovation but also collaborative relationships among teachers, students, parents, and community organizations. Research by Khairul Anam and colleagues (2022) demonstrates that inclusive collaboration serves as a key mechanism for creating a supportive school environment where all participants contribute to educational success. Their findings indicate that sustainable educational ecosystems emerge when schools build partnerships that extend beyond the classroom and involve multiple stakeholders in decision-making.

Recent research by Shalabayeva et al. (2025) further emphasizes the Future Classroom Lab concept's potential to prepare future teachers to work in inclusive educational environments. The authors highlight the importance of combining flexible learning spaces, innovative pedagogical approaches, and practical teacher preparation within the Future Classroom framework. In their research, Kazakhstani scientists A. D. Zhumageldieva and G. A. Abayeva emphasize the need to implement inclusive education through systemic models. They highlight barriers that arise when integrating children with special educational needs into the general education environment and point to a lack of teacher readiness as a major challenge. They argue that inclusive education should be complemented by models that address teachers' specific professional needs, rather than relying solely on legislative changes. The authors also note that a lack of understanding of the theoretical foundations of inclusion, limited knowledge of the psychological characteristics of children with special needs, and difficulty choosing effective methods and technologies reduce teachers' confidence in inclusive education. This situation creates instability in teachers' professional activities and affects the quality of the inclusive environment (Zhumageldieva & Abayeva, 2024).

Continuing this line of reasoning, Kudarinova A. S. and Autayeva A. N. specifically analyze the professional and personal readiness of future teachers to implement inclusive education (Kudarinova & Autayeva, 2022). The authors describe inclusive education as a phenomenon that involves providing high-quality, accessible education for everyone, based on UNESCO principles, and emphasize that the main foundation is each student's perception based on their individual characteristics.

The problem of readiness in inclusive education is not only voiced at the general level, but also deepened in the context of working with special categories. A striking example is the work with students with autism spectrum disorders. Authors Sardarova Zh. I. and Sarsenbay U., one of the researchers who specifically raised the relevance in this area, note that the organization

of education for students with autism spectrum disorders in modern conditions of inclusive education requires a special approach (Sardarova & Sarsenbay, 2025). According to them, since this category of children often faces serious difficulties in learning, adaptation, and social interaction, their integration into the general education environment does not occur “spontaneously.” Instead, it requires proper harmonization of special education forms, flexible implementation, and support tailored to individual needs.

Sardarova Zh. I., Kismetova G. N., and Kadyrgalieva S. I. show that the psychological readiness of future teachers for professional activity in an inclusive environment is of particular importance. The authors consider psychological training as “complex synthetic knowledge” and divide its structure into two main groups: motivational-emotional and cognitive components (Sardarova et al., 2024). In other words, readiness for inclusion is not measured by a single “intention”: on the one hand, the emotional response, fear, or perception of the teacher; and on the other hand, the level of actual knowledge and understanding go hand in hand.

An important aspect of this study is the relationship between psychological training and emotional intelligence. The authors believe that a teacher with high emotional intelligence can create a psychologically supportive environment in an inclusive setting, ensuring both their own safety and their students’ safety. Conversely, an emotionally unstable adult’s reaction can undermine children’s self-confidence, increase anxiety, and turn negative experiences into a constant role model. Therefore, developing emotional intelligence to adapt to an inclusive environment is not only a personal development issue but also a professional necessity.

One study that explains the formation of a teacher’s readiness through real opportunities at the university level is the work of G. K. Shugaeva and N. Shmankyzy (Shugaeva & Shmankyzy, 2020). The authors consider how universities can prepare future specialists for an inclusive school education system and associate the essence of inclusive education not only

with the child’s resources, but primarily with the resources of the surrounding educational environment.

Gavrilova E. A. proposes the hypothesis that including a special author’s discipline in the curriculum can effectively prepare future teachers for work in an inclusive educational environment (Gavrilova, 2022). According to E. A. Gavrilova, the frequent lack of preparation of school teachers for working with “special” children is largely due to psychological barriers, a lack of psychological and pedagogical knowledge, and methodological approaches. Therefore, training should be carried out purposefully during professional training, i.e., at the university stage. An important study that complements this logic at the “system model” level is authored by I. A. Akhmetshina and A. A. Loseva. The authors note that as inclusive education develops, social demand and educational standards require teacher training to be organized at a new level (Akhmetshina et al., 2019).

Gorbunova N.V. shows that the tasks of a specialist working in an inclusive environment include several areas: organizational, educational, and research activities, as well as psychological support, medical rehabilitation, and information and consulting services (Gorbunova, 2017). From the author’s perspective, the goal of inclusive education goes beyond academic outcomes and includes creating a unified environment, socialization, psychological and pedagogical support, individualized educational trajectories, systematic work with parents, and fostering positive attitudes among all participants.

These ideas naturally align with the concepts of “system model” and “practice-oriented training” discussed above: inclusive competence is viewed as comprehensive training shaped by an organized environment and coordinated teamwork, rather than as an individual skill. Another important area of research is developing the project competencies future teachers need for an inclusive environment. This problem can be addressed using the project-competence approach proposed by Ketrish et al. (2016). The authors note that, in the context of

inclusive education, teacher readiness requires changes to the professional training process that go beyond individualized approaches and general pedagogical education. Smantser and Ignatovitch (2015) similarly emphasize the need to prepare future teachers through experience for work in inclusive educational environments.

The literature review suggests that preparing future teachers for inclusive educational environments should be based on systemic, multi-level, and practice-oriented models. However, the analyzed works often focus on the inclusive environment at the school level or on individual subjects and training components, and do not sufficiently address the need to provide future teachers with a comprehensive, “live” model of working in an inclusive environment at the university. This highlights the need for innovative educational models that develop future teachers’ professional, psychological, and project-related competencies in a single environment.

Materials and Methods. The study employed a mixed-methods quasi-experimental research design to examine the effectiveness of an adapted Future Classroom Lab (FCL) model in developing an inclusive education ecosystem within a university-based teacher education context. The mixed-methods approach was selected because developing an inclusive educational environment involves both measurable changes in students’ professional competencies and qualitative characteristics of the learning environment, including accessibility, flexibility, interaction, collaboration, and pedagogical support.

The quantitative component assessed changes in future teachers’ self-efficacy for inclusive practices and evaluated the quality and inclusiveness of the learning environment before and after the intervention. Systematic observations of instructional interactions and expert assessment of the educational environment supported the qualitative component.

The research was organized into four interconnected stages. The first stage was theoretical and conceptual. At this stage, scientific literature and international practices concerning inclusive education, innovative

learning environments, and the Future Classroom Lab model were analyzed. The analysis focused on principles of accessibility, flexibility, learner-centered education, collaboration, personalization, digital technology integration, and adapting learning environments to diverse educational needs. The theoretical analysis identified key characteristics to incorporate into an adapted FCL environment for inclusive teacher education.

The second stage was design and adaptation. The principles of the Future Classroom Lab model were adapted to the context of university-based teacher education and inclusive education. The adapted learning environment emphasized flexible organization of learning spaces, accessibility, movable furniture, collaborative and individual learning zones, digital resources, opportunities for differentiated learning activities, and interaction among students and instructors. The university educational space was therefore conceptualized not simply as a physical classroom but as an integrated ecosystem combining spatial, technological, pedagogical, and psychosocial components.

The third stage was implementation and observation. During this stage, students in the experimental group participated in learning activities organized within the adapted FCL environment. The Classroom Assessment Scoring System (CLASS) was used to assess the quality of instructional interactions. The environmental characteristics of the university learning space were assessed using an adapted version of the school-Age Care Environment Rating Scale (SACERS).

The fourth stage was the evaluation stage. At this stage, the Teacher Efficacy for Inclusive Practices (TEIP) questionnaire assessed future teachers’ self-efficacy in inclusive educational practices. The study also conducted environmental and instructional assessments and compared pre-test and post-test results to determine changes after implementing the adapted FCL model.

Participants. The study involved 78 undergraduate students enrolled in teacher education programs at a pedagogical university in Kazakhstan. Participants were randomly

assigned to an experimental group ($n = 39$) and a control group ($n = 39$).

The experimental group participated in learning activities organized within an adapted Future Classroom Lab environment based on the principles of inclusive education. The control group continued their studies in traditional classroom settings during the same period.

The intervention lasted 12 weeks (one academic semester). Data were collected at two measurement points: before implementing the adapted FCL model (pre-test) and after completing the intervention (post-test). The pre-test provided baseline measurements, while the post-test assessed changes in participants' inclusive competencies and perceptions following the intervention.

Random assignment of participants to experimental and control groups reduced potential selection bias and increased group comparability. Both groups followed the same general teacher education curriculum, but the learning environment and activities differed in their organization.

Research Instruments. Three complementary instruments were employed to assess different components of the inclusive education ecosystem: the Teacher Efficacy for Inclusive Practices (TEIP) questionnaire, an adapted School-Age Care Environment Rating Scale (SACERS), and the Classroom Assessment Scoring System (CLASS).

Teacher Efficacy for Inclusive Practices (TEIP)

The Teacher Efficacy for Inclusive Practices (TEIP) scale assessed future teachers' perceived self-efficacy in implementing inclusive educational practices. The instrument consists of 18 items organized into three dimensions: efficacy in inclusive instruction, efficacy in collaboration, and efficacy in managing student behavior. (Sharma et al., 2012).

Participants responded to each item using a 6-point Likert scale, ranging from 1 ("strongly disagree") to 6 ("strongly agree"). Higher scores indicated greater perceived self-efficacy for working in inclusive educational settings.

The TEIP was administered at both measurement points, before and after the 12-

week intervention. Changes in TEIP scores were used to determine whether participation in the adapted FCL environment was associated with increased future teachers' confidence in applying inclusive practices.

Classroom Assessment Scoring System (CLASS). The Classroom Assessment Scoring System (CLASS) was used to evaluate the quality of instructional interactions within the learning environment. The instrument assessed three broad domains: Emotional Support, Classroom Organization, and Instructional Support. (Pianta et al., 2008).

The Emotional Support domain examined the quality of interpersonal relationships, responsiveness, and the emotional climate of the learning environment. Classroom Organization focused on the organization and management of learning activities, student engagement, and effective use of learning time. Instructional Support addressed pedagogical practices supporting students' cognitive engagement, learning processes, and higher-order thinking.

CLASS observations were conducted at both pre-test and post-test stages. Two trained external experts conducted the observations independently. The observers were not involved in the teaching process and therefore did not participate in implementing the adapted FCL intervention.

Inter-rater agreement between the two observers exceeded 0.85, indicating satisfactory agreement and supporting the reliability of the observational assessment.

Data Collection Procedure. Data collection was conducted during a 12-week academic semester and included pre-intervention and post-intervention measurements. At the pre-test stage, both the experimental and control groups completed the TEIP questionnaire. At the same stage, the adapted SACERS instrument assessed the educational environment, and CLASS observations established baseline characteristics of instructional interactions (Harms et al., 1996). Following the baseline assessment, the experimental group participated in learning activities within the adapted FCL environment for 12 weeks. The environment was organized around flexibility, accessibility, collaboration,

personalization, digital technology integration, and learner-centered education.

Ethical Considerations. The study followed ethical principles applicable to educational research. Participation was voluntary, and all participants provided informed consent before data collection. Participants were informed about the study's purpose, the procedures involved, the voluntary nature of participation, and their right to withdraw without academic or other negative consequences. The researchers-maintained confidentiality and anonymity throughout the research process. Participants were identified by code rather than name, and individual identifying information was not included in the analytical database or published results. The collected data were used exclusively for scientific purposes. The researchers also adhered to academic integrity principles throughout all stages of the study. The research data were not intentionally falsified or manipulated, and the sources used to develop the theoretical and methodological framework were appropriately acknowledged. Copyright and intellectual property requirements were respected.

Data Analysis. Quantitative data were analyzed using IBM SPSS Statistics 29.0. We calculated descriptive statistics, including means and standard deviations, for the main study variables. We assessed the internal consistency of multi-item scales using Cronbach's alpha.

The distribution of quantitative variables was examined before inferential analysis to determine the appropriateness of parametric statistical procedures.

Results. As a result of the first theoretical and conceptual stage, foreign scientific works and international experience in applying the Future Classroom Lab model in inclusive education were comprehensively analyzed and systematized. The analysis revealed that in the organization of inclusive education in European countries and the United States, the structure of the educational space, pedagogical interaction, and the assessment system are not considered separately. Instead, these components are designed as a unified system focused on individual student needs.

Practical work in the Future Classroom Lab (FCL) environment has led to significant changes in future teachers' professional development. In particular, three main universal inclusive skills have been systematically developed in their professional image. These skills were identified through qualitative observations conducted during the study, an analysis of students' practical assignment progress, and the results of the TEIP survey. The data showed that future teachers became more confident working in an inclusive environment and developed a more conscious and purposeful approach to their professional activity.

Table 1

Universal inclusive skills of the future teacher

Universal skill		Content description	Formation mechanism in the FCL environment
Diagnostic evaluation	and	Identification of cognitive, emotional and behavioral characteristics of the student	Control cards, case analysis, digital monitoring
Didactic adaptation		Adaptation of the same reading content to different levels of perception	Multimodal content, level tasks
Inclusive assessment		Taking into account the dynamics of individual student progress	Formative and criterion-based assessment

Developing diagnostic and evaluative skills changed the future teacher's attitude toward the student. Students began to see the student not as an abstract individual who meets the "average standard," but as an individual with a unique learning pace and capabilities. This skill

becomes an essential foundation for teachers to make independent, informed decisions in an inclusive classroom. The results showed that future teachers prioritized functional pedagogical assessment over defectological diagnostics, aligning with current inclusive

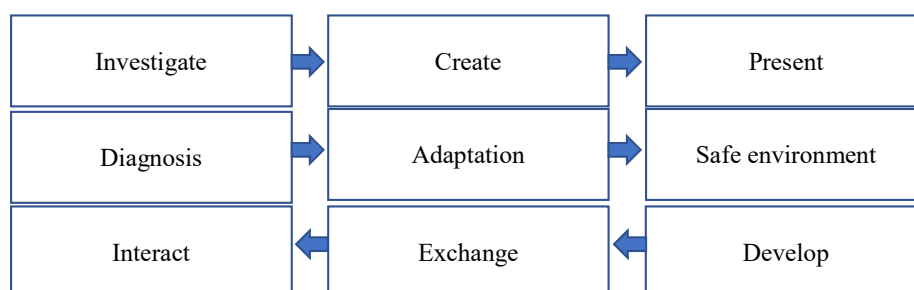
education requirements. The development of didactic adaptation skills clearly demonstrated the growth of students' ability to flexibly reframe the learning content. Through experimentation, they realized that the same learning material could be presented at multiple levels, and they gradually moved away from the "one program, one approach" principle. This shows that future educators are willing to consciously choose learning strategies that meet students' diverse needs in an inclusive environment.

The development of inclusive assessment skills revealed a significant shift in the pedagogical approach to assessment. Assessment was no longer seen as a tool for control or selection,

but rather as a mechanism that supports student development and reflects their progress. This change means that the professional culture of future teachers has reached a new quality level. The results showed that the regional structure of the Future Classroom Lab environment supports the comprehensive development of the future teacher's inclusive competence. These areas are organized as an interconnected, complementary, and holistic system, rather than as elements that operate independently. This interaction creates conditions for viewing the learning process as a cycle aimed at continuous professional development (Figure 1).

Figure 1

Cyclical model of an inclusive ecosystem based on FCL



This cycle clearly demonstrates the logic of future teachers' actions in an inclusive environment. First, teachers identify students' learning characteristics and psychosocial needs and conduct initial diagnostics. Based on this data, the learning content and tasks are adapted to different abilities. Next, students have the opportunity to present their work in a safe,

supportive environment. The Future Classroom Lab environment consists of six interconnected areas. Each region focuses on developing specific skills and competencies future teachers need to work in an inclusive environment. These areas function not individually, but as a unified system, providing comprehensive professional development for teachers (Table 2).

Table 2

FCL areas and emerging inclusive competencies

FCL Zone	Main action	Formed competence
Investigate	Analysis of the student's educational and individual needs	Analytical thinking
Create	Development of adapted educational materials	Didactic flexibility
Present	Presentation of results in a safe environment	Psychosocial support
Interact	Organization of classroom interaction	Inclusive management
Exchange	Group and collaborative work	Social integration
Develop	Reflection and self-development	Emotional stability

The Investigate area teaches the future teacher to understand the student first. At this

stage, students analyze the student's learning pace, interests, emotional state, and areas that

need support. As a result, the future teacher in an inclusive environment becomes accustomed to teaching based on real data rather than random decisions. The learning content is recompiled based on the data obtained in the Create area. The future teacher will learn to present the same topic at different levels and in different formats. This stage builds didactic flexibility and helps the future teacher move away from a “one-size-fits-all” approach.

The Present Zone emphasizes safety and support in an inclusive environment. Here, students can freely present their work without fear of criticism. For future educators, this area serves as an important learning platform for giving feedback while maintaining students’ self-esteem. The Interact Zone focuses on developing classroom management and collaboration skills. Students learn effective leadership techniques based on cooperation and understanding rather than strict discipline control when working with students with diverse abilities. This is considered a crucial aspect of inclusive management.

The Exchange area is focused on collaboration and sharing experiences. Here, students recognize the importance of teamwork and operate in an environment that values each individual’s contributions. As a result, social awareness is enhanced, and an inclusive culture is fostered. The Developer area focuses on reflection and professional self-development. Future educators review their actions, analyze their achievements, and address their challenges. This phase enhances emotional resilience and promotes tolerance for professional stress.

The FCL areas develop future teachers’ inclusive competence not only at the knowledge level but also at the cognitive, social, and emotional levels. This approach allows for the development of inclusive education as a holistic professional culture rather than a collection of individual methods. The study’s quantitative results demonstrate the effectiveness of the Future Classroom Lab ecosystem through accurate data. The findings show a significant increase in future teachers’ confidence in working in an inclusive environment.

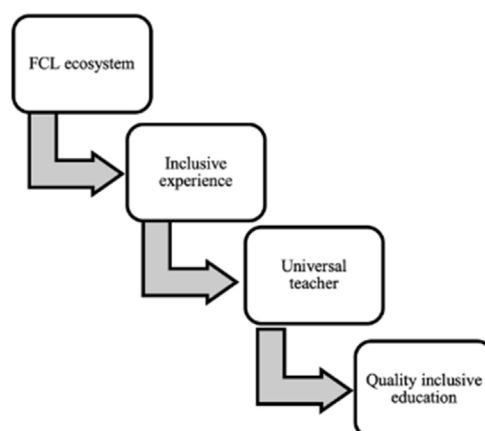
Table 3

Changes in TEIP scores

Indicator	Initial	Final	Changes
Confidence in inclusive education	2,8	3,9	+40%
Adaptation of tasks	2,6	3,8	+46%
Behavior management	2,7	3,7	+37%

The increase in all TEIP scores indicates that future teachers have increased their internal trust in working in an inclusive environment. In particular, the increased ability to adapt learning tasks indicates that students are ready to be flexible and aware in an inclusive classroom. Additionally, improved behavior management scores indicate that future teachers have reduced their fear of challenging teaching situations. These changes are directly related to the FCL’s practice-oriented, error-tolerant, and supportive

environment. In such an environment, students have the opportunity to try their hand at something, analyze their mistakes, and become more confident in their professional abilities. The results obtained using the SACERS scale showed that the Future Classroom Lab environment fully meets inclusive requirements not only at the formal level, but also in terms of content and organization. The impact of the FCL ecosystem can be seen in the following logical chain (Figure 2).

Figure 2*Logical sequence of FCL ecosystem effects*

The results of the study show that the Future Classroom Lab model can create a full-fledged, sustainable, and effective inclusive education ecosystem in the process of training future teachers. This model allows for the development of inclusivity not as a collection of individual methods, but as an integral part of a teacher's professional culture. Results for the criterion of organizing the educational process revealed the lesson structure. They showed increased use of educational instruction; future teachers have begun to plan educational activities more consistently.

The increase in cognitive development stimulation indicators suggests that students are using more tasks that encourage them to think, analyze, and justify their opinions. This demonstrates future teachers' readiness to engage in active, meaningful learning in an inclusive environment. The quantitative data from the CLASS methodology show that the Future Classroom Lab ecosystem systematically enhances the culture of pedagogical communication, emotional sensitivity, and the quality of professional interaction among future teachers.

Discussion. The results showed that the adaptive model of the Future Classroom Lab (FCL) can serve as a basis for building an inclusive education ecosystem. In this section, the obtained data are discussed in the context of the original research questions and assumptions, and their theoretical and practical significance is revealed.

The study analyzed the current state of the inclusive educational environment in Kazakhstan against SACERS international standards. The results showed that the main limitation in ensuring inclusivity is not the material and technical base, but the lack of effective pedagogical approaches. In other words, the availability of space and modern equipment is not enough to create a self-sustaining inclusive ecosystem.

The analysis contributes to the harmonious interconnection of pedagogy, technology, and space as the main condition for the effective development of an inclusive environment. The main advantage of the Future Classroom Lab model is that it can combine these three components into a single system. This approach aligns with the ecosystem approach widely used in international practice and supports the comprehensive development of inclusive education.

During the study, attitudes changed significantly. Inclusion is now perceived not only as the "responsibility of a specialized professional, such as a speech therapist", but also as part of the professional responsibility of any educator. This change shows that inclusion has become a common, universal value in future teachers' professional self-awareness. Additionally, this result proves that the integrated learning model is effective and plays an important role in preparing educators to work in an inclusive environment.

One of the study's main assumptions was that the Future Classroom Lab environment could serve as a safe, experimental platform for future educators to combine theory and practice. The results of the study showed that this assumption was fully confirmed. While traditional university learning environments often focused on theoretical knowledge, the FCL laboratory allowed students to engage in professional activities earlier by simulating specific inclusive situations.

In the study, students participated in solving virtual and physical cases that focused on working with children with special educational needs before they even started school. This format of work transformed the theoretical understanding of "I know" into a reflective competence that can critically approach the specific action of "I can" and my work. Based on the data obtained, it was found that graduates who have completed the FCL model have a school adaptation period that is approximately half as long as that of those who have completed traditional training. This result directly contributes to reducing the professional stress that arises from working in an inclusive environment and to the stability of teaching staff.

The results of the study have shown that the impact of the Future Classroom Lab model is not limited to the educational process. The social and economic consequences of this model are also evident and systemic. From a social perspective, increasing the number of teachers who are able to provide an inclusive environment reduces the isolation of children with special educational needs from society. Children who are educated in such an environment are exposed to social interaction at an early age and begin to feel like full members of society. In the long term, this process helps to reduce social inequality. From an economic perspective, providing teachers with the necessary skills to create an inclusive environment can help reduce the cost of retraining staff. In addition, the active participation of individuals with inclusive education in the future labor market will bring additional human capital to the country's economy. In this sense, the Future Classroom

Lab model can be considered as a long-term investment with high social significance.

Conclusion. The research conducted has shown that the implementation of the adapted Future Classroom Lab (FCL) model in the training of future teachers provides a real opportunity to create an effective, sustainable, and systemic ecosystem of inclusive education. The results of the study clearly demonstrate the importance of considering inclusive education not as a collection of individual methods and techniques, but as a holistic system that integrates pedagogical approaches, space, and technologies. The research objectives and tasks were fully achieved. The study, based on a mixed methodology, allowed for a comprehensive analysis of the level of development of inclusive competencies among future teachers and provided a scientific basis for the effective implementation of the Future Classroom Lab model in higher education institutions. The combined use of qualitative and quantitative data ensured the reliability and validity of the results obtained.

The results showed that there were clear qualitative changes in the professional image of future teachers. In particular, students who participated in the Future Classroom Lab ecosystem consistently developed diagnostic and evaluative skills, content adaptation skills, and the ability to perform inclusive criterion-based assessments. These skills were identified as the universal professional foundation necessary for successful work in an inclusive classroom. The 40% increase in self-confidence on the TEIP scale provides strong evidence of the psychological readiness of future teachers to work in an inclusive environment.

The results of the study showed that the regional structure of the FCL model is crucial for the training of future teachers. The functioning of the Investigate, Create, Present, Interact, Exchange, and Develop zones as an interconnected system allows for the equal development of the cognitive, social, and emotional competencies of future teachers. The learning environment was rated as "very good" on the SACERS scale. The analysis clearly demonstrated that the Future Classroom Lab

model is an effective tool that combines theory and practice. Modeling an inclusive classroom in a university setting allows for a shorter period of professional adaptation for future teachers, avoiding professional stress and creating ready, reliable personnel for school practice. In this sense, the FCL laboratory serves as a safe and practical professional testing ground for future teachers.

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Reflective Skills of Future Primary School Teachers in Inclusive Education: A Structural-Functional Model

Abstract

Introduction. The article addresses the need to develop reflective skills in prospective primary school teachers, driven by the shift from formal integration to genuine inclusion. The study aims to provide a theoretical rationale and develop a structural-functional model for developing reflective skills in prospective primary school teachers in an inclusive context: *methodology and methods.* The study uses analysis, synthesis, generalization, and modeling, drawing on personality-oriented, activity-based, and systemic approaches. Reflective skills are conceptualized as an integrative professional-personal quality that enables the teacher to analyze and transform their own practice within the inclusive process. *Results.* A structural-functional model has been developed that integrates target, content (motivational-value, cognitive, and activity components), procedural (stages, methods, forms), and outcome-evaluative (criteria and levels) components. The study identified the pedagogical conditions for developing reflective skills. *Scientific novelty.* The model orients professional training toward reflective skills as a mechanism for the transition from emotionally reactive responding to well-grounded pedagogical decision-making, and from formal integration to genuine inclusion - *practical significance.* The model can be implemented in teacher education, including through an elective course that ensures prospective primary school teachers purposefully develop reflective skills.

Keywords: reflection, reflective skills, reflective skills of a future primary school teacher, model for the formation of a teacher's reflective skills.

Introduction. Inclusive education, a defining benchmark for reforming the national education system, establishes every child's right to equal access to education, regardless of special educational needs and individual capabilities (Resolution of the Government of the Republic of Kazakhstan No. 1143, 2024). Implementing this principle has changed the requirements for professional training: prospective primary school teachers must work not with a relatively homogeneous class, but with a heterogeneous community of learners who differ in their pace of mastering material and in their sensory, cognitive, and emotional characteristics.

In practice, however, the declared inclusion is often implemented as integration: a child with special educational needs is placed in a mainstream class, while the school and the

educational process are not restructured to meet the child's needs (Mamerkhanova, 2025). The formal presence of a young learner does not ensure their full participation and points to a gap between the normatively established principle of inclusion and actual pedagogical practice. Bridging this gap depends directly on the primary school teacher's ability to analyze their own practice and restructure it in response to the child's special educational needs, making the development of the prospective teacher's reflective skills a key condition for the transition from integration to genuine inclusion.

These skills are grounded in reflection-a meaningful, systematic analysis of one's own experience aimed at its transformation (Dewey, 1933; Schön, 1983). In contemporary pedagogy, it is understood not as spontaneous

contemplation but as a structured thought process spanning levels from the technical aspects of practice to the teacher's professional identity and value foundations (Korthagen, 2004). The reflective skills formed on this basis become a key professional competence of the prospective teacher. In an inclusive context, where universal ready-made solutions are absent, reflective skills enable the teacher to question their own assumptions, identify implicit stereotypes in perceiving students, and consciously restructure their practice to suit the individual child (Hatton & Smith, 1995; Rodgers, 2002). Researchers emphasize that, when working with learners with special educational needs, reflective skills serve not as a supplement but as a system-forming mechanism for professional growth, enabling a shift from emotionally reactive responding to well-grounded pedagogical decision-making (Korthagen & Vasalos, 2005; Machost & Stains, 2023).

The degree to which the problem has been studied is characterized by considerable scholarly attention to reflection. The theoretical and methodological foundations of reflective practice were laid in works that defined reflection as the basis of a teacher's professional thinking (Dewey, 1933; Schön, 1983) and were further developed in models of structured reflection, among which the ALACT cycle and the concept of "core reflection" have gained the widest recognition; the latter distinguishes successive phases of making sense of experience-action, looking back, awareness of essential aspects, creating alternative methods, and trial (Korthagen, 2004; Korthagen & Vasalos, 2005). A separate line of research is devoted to substantiating a reflective orientation as an alternative to the technocratic ("craft") model of teacher training, in which the prospective teacher is regarded not as a passive executor of ready-made prescriptions but as a subject capable of justifying their own professional decisions and critically examining their value foundations (Zeichner & Liston, 2014). Within this line of research, a substantial body of work has emerged on the development of prospective teachers' reflective skills at the stage of professional training, where reflection is interpreted as a means of bridging the gap between

theoretical knowledge and actual practice; at the same time, researchers note that reflective skills do not arise in students spontaneously and require purposeful, specially organized development (Hatton & Smith, 1995; Rodgers, 2002). In special and inclusive education, reflective skills are studied as a condition for high-quality practical preparation for working with learners with special educational needs and as a tool for professional growth in this field (Şerban & Hathazi, 2025).

In parallel, research on prospective teachers' readiness for inclusive education is actively developing. Empirical studies consistently show that the attitudes, self-efficacy, and practical experience of students in teacher education programs substantially determine their ability to implement inclusive practices (Boyle, Barrell, Allen, & She, 2023). Systematic reviews show that prospective teachers' self-efficacy regarding inclusion forms primarily through direct experience interacting with learners with special educational needs and through applying professional knowledge in practice. In contrast, theoretical instruction alone cannot develop it (Wray, Sharma, & Subban, 2022). In the context of the Republic of Kazakhstan and Central Asia, research reveals that prospective teachers are insufficiently prepared to work in an inclusive environment, and that teacher education institutions lack a coherent, consistently structured strategy for their preparation, as a result of which students' methodological readiness, skills, and value-motivational attitudes remain poorly developed (Makoelle & Burmistrova, 2021; Prisiazhniuk, Makoelle, & Zangieva, 2024).

An analysis of the literature reveals that reflective skills and readiness for inclusion are studied predominantly as separate, weakly connected subject areas: works on pedagogical reflection, as a rule, do not take into account the specific features of the inclusive environment, while studies of inclusive readiness rarely reveal the reflective component as a mechanism of its formation. This defines a contradiction between, on the one hand, the recognition of reflective skills as a necessary condition for the transition from formal integration to genuine inclusion

and, on the other hand, the absence of a coherent pedagogical model that ensures the purposeful development of these skills specifically in prospective primary school teachers, taking into account the specific features of inclusive education. This contradiction defines the research problem: what content, structure, and organizational-pedagogical support should a model have to effectively develop the reflective skills of prospective primary school teachers within the conditions of inclusive education?

The need to develop the model stems from the fact that the fragmentary inclusion of reflection in teacher training does not ensure the systematic development of reflective skills or link them to the specific professional tasks of the inclusive primary school. Accordingly, the research question is formulated as follows: what are the structure and content of a model for developing the reflective skills of prospective primary school teachers within the conditions of inclusive education that ensures the transition from the reproductive assimilation of pedagogical knowledge to conscious, reflectively regulated activity in an inclusive environment? The theoretical significance of the study lies in the fact that the proposed model conceptually unites two previously disparate areas—the theory of pedagogical reflection and research on readiness for inclusive education—and thereby substantiates reflection as a system-forming mechanism for bridging the gap between integration and inclusion, and operationalizes this mechanism in the form of interconnected structural components of prospective teacher training.

The purpose of the work is to develop and provide a theoretical rationale for a model for developing the reflective skills of prospective primary school teachers within the conditions of inclusive education. The article presents the theoretical rationale and describes the developed model, identifies its structural components, and discusses the results.

Materials and Methods. The study is conceptual (theoretical) in nature, and its design follows a model-building approach as one way to design conceptual work. Achieving the stated aim required applying a set of theoretical research methods to ensure the

scientific validity of the model's development. The analysis method was used to break down the complex phenomenon of reflective skill development into its constituent elements. In the study, analysis made it possible to identify the structural components of prospective teachers' reflective skills, differentiate approaches to organizing pedagogical reflection in domestic and international practice, and determine the specific features of the inclusive educational environment as the context in which these skills are formed and realized. The synthesis method ensured the integration of the elements identified during the analysis into a coherent system. The synthetic approach made it possible to integrate theoretical propositions on pedagogical reflection with research on professional readiness for inclusive education, to combine the psychological and pedagogical patterns of the development of reflective skills with the specific features of primary school teacher training, and to form a holistic understanding of the mechanisms for developing reflective skills within the conditions of inclusion.

The method of generalization was used to identify the essential features and patterns characteristic of the process of developing reflective skills. Generalizing the results from the scholarly and pedagogical literature made it possible to formulate the theoretical propositions that determine the content and structure of the model being developed and to identify the invariant characteristics of the successful organization of prospective teachers' reflective activity at the stage of professional training. The method of concretization ensured the transition from abstract theoretical propositions to their practical embodiment in the context of training a primary school teacher for an inclusive environment. This method made it possible to determine the specific forms, methods, and means of developing reflective skills, adapted to the specific features of inclusive primary education and the professional tasks prospective teachers encounter when working with learners with special educational needs.

Modeling served as the key research tool, enabling the design of the system's structure and content for developing the reflective

skills of prospective primary school teachers within the conditions of inclusive education. Modeling is the process of creating an idealized representation of a pedagogical system or process that captures its essential structural and functional characteristics, the interrelationships among its components, and the mechanisms for achieving planned results (Susanto, Rachmadtullah, & Rachbini, 2020). In this study, modeling made it possible to visualize the complex interrelationships among the target, conceptual-methodological, content, procedural, and outcome components, and to substantiate the logic of their interaction in the educational process. In pedagogical research, a model performs several functions: a representative function, reflecting a simplified yet adequate representation of complex pedagogical reality; an interpretive function, providing an understanding of the internal mechanisms and patterns of the process under study; a predictive function, making it possible to anticipate the results of implementing the designed system in educational practice; and an instrumental function, serving as the basis for developing specific methodological solutions.

Results. The developed model for the formation of reflective skills in prospective primary school teachers within the conditions of inclusive education constitutes a coherent system of five interconnected components—target, conceptual-methodological, content, procedural, and outcome—united by a single logic of transition from the reproductive assimilation of pedagogical knowledge to conscious, reflectively regulated professional activity (Figure 1).

The target component defines the model's strategic orientations and sets the direction of the entire holistic pedagogical process of the prospective teacher's professional training. It is determined by the social demand for a teacher capable not only of formally including a child with special educational needs in the classroom, but of ensuring the child's full participation, which presupposes a transition from *de facto* integration to genuine inclusion. In line with this demand, the aim is to develop in prospective primary school teachers reflective skills that ensure the conscious design, analysis, and

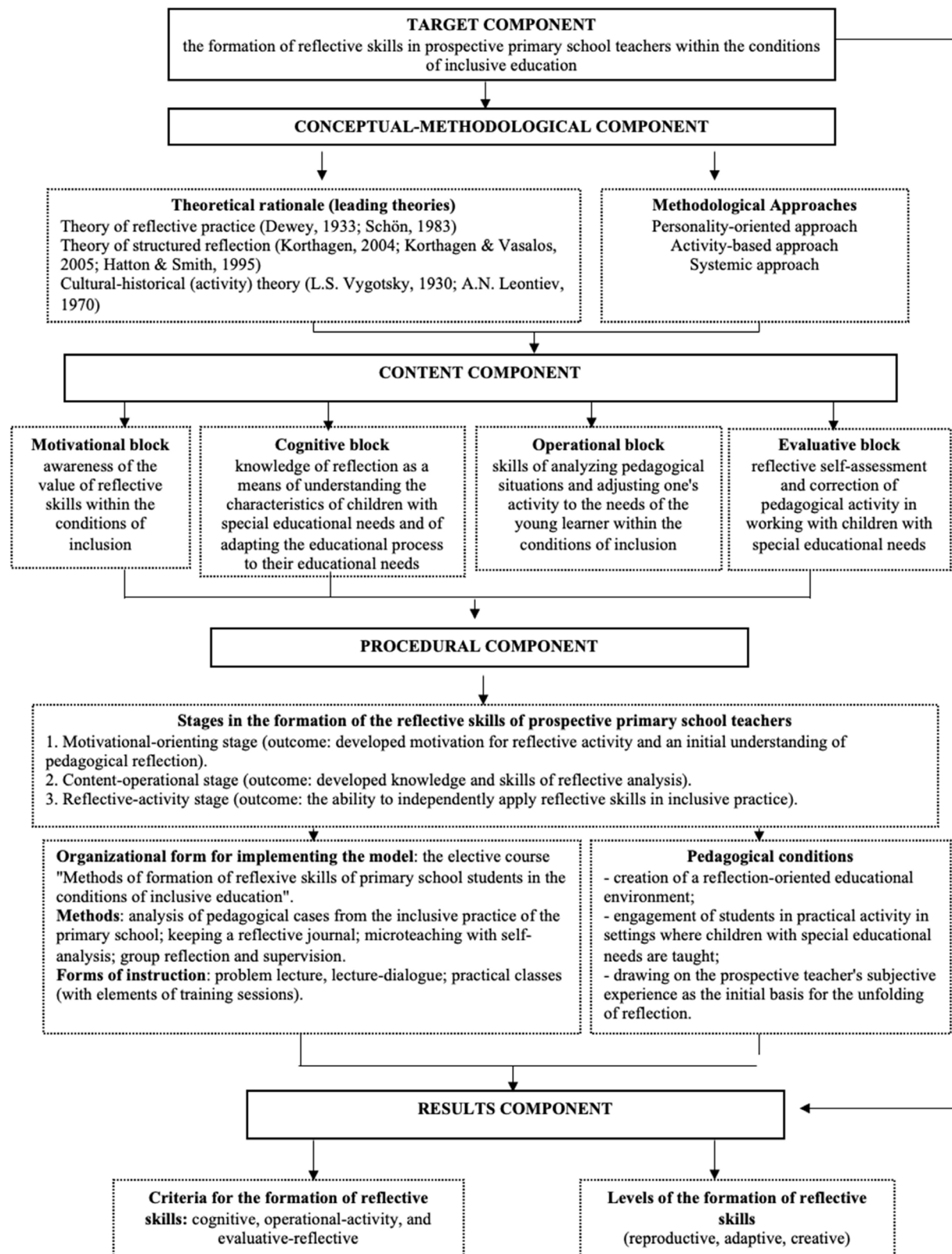
restructuring of their own pedagogical activity in the inclusive educational environment. The aim is specified through a system of objectives: to form stable motivation for the reflective analysis of professional activity within the conditions of inclusion; to ensure the mastery of a system of knowledge about pedagogical reflection, special educational needs, and ways of adapting the educational process; to develop the operational skills of observing, interpreting, and restructuring pedagogical actions in relation to the individual young learner; and to form the capacity for self-assessment and correction of one's own activity. The target component performs a system-forming function, determining the content, logic, and expected outcome of all the subsequent components of the model.

The conceptual-methodological component reveals the model's theoretical foundations and defines the methodological approaches for organizing the process of developing reflective skills. The component is structured in two layers: a layer of underlying theories that establish an understanding of the nature of reflection and the mechanisms of its formation, and a layer of methodological approaches that ensure these theories are realized in the model's design.

The first theoretical foundation of the model is the theory of reflective practice, developed in the works of J. Dewey and D. Schön, which defines reflection as a systematic, disciplined analysis of one's own experience that underlies the teacher's professional thinking and ensures the transformation of experience into meaningful professional action (Dewey, 1933; Schön, 1983). This theory substantiates the very object of formation—reflective skills—as the core of the teacher's professionalism. The second foundation is the theory of structured reflection, according to which reflection lends itself to operationalization and develops as a sequence of phases—from action and its analysis to awareness of essential aspects, the creation of alternatives, and trial—while its effectiveness is determined by the depth of making sense of experience, which differs across levels from descriptive to critical (Korthagen, 2004; Korthagen & Vasalos, 2005; Hatton & Smith,

Figure 1

Model for the Formation of Reflective Skills in Prospective Primary School Teachers within the Conditions of Inclusive Education



1995). This theory explains how reflective skills can be developed and assessed in terms of depth. The third foundation is the cultural-historical

(activity) theory, developed in the works of L. S. Vygotsky and A. N. Leontiev, according to which higher mental functions and professional

skills are formed not through the transmission of ready-made knowledge but in the process of the subject's active, mediated activity (Vygotsky, 1978; Leontiev, 1978; Cong-Lem, 2022). This suggests that reflective skills develop only when the student is engaged in real activity aimed at analyzing and transforming their own professional experience.

The model operationalizes these theoretical foundations through three complementary methodological approaches. The systemic approach ensures that reflective skills are viewed as a coherent structure of interconnected elements, and the model itself as a unified system with a coordinated aim, content, process, and outcome. The activity-based approach, drawing on cultural-historical theory, establishes the logic of developing reflective skills through the student's active engagement in analyzing and transforming the professional experience they carry out. The personality-oriented approach recognizes that reflection concerns not only the technical aspects of activity but also the prospective teacher's professional beliefs, values, and identity, and therefore relies on their subject position and individual developmental trajectory.

The content component defines the internal structure of the reflective skills being developed and the substance of the training process. Within the reflective skills of the prospective primary school teacher, four interconnected elements are distinguished. The motivational element reflects an awareness of the value of reflection, a sustained interest in analyzing one's own activity, and a need for professional self-improvement in the inclusive environment. The cognitive element encompasses knowledge of the essence and levels of pedagogical reflection, the psychological and pedagogical characteristics of children with special educational needs, and ways to adapt the educational process. The operational block includes the skills to observe one's own actions and learners' responses, interpret pedagogical situations, identify difficulties, and design and carry out activity restructuring in response to the needs of the individual child. The evaluative element reflects the capacity for adequate self-assessment of the results of professional activity,

awareness of one's own strengths and areas for development, and correction of pedagogical actions. The substantive content is aligned with the professional tasks that arise for the primary school teacher in the inclusive classroom and serves as the basis for designing the means of developing reflective skills.

The procedural component reveals the organizational and technological side of developing the reflective skills of prospective primary school teachers. It defines the logic of how the process under study unfolds over time: its stages, methods, forms, and the set of pedagogical conditions that ensure effectiveness. The process is designed as a stage-by-stage progression with a consistent increase in the student's subject position and independence-from activity externally regulated by the instructor to the independent, conscious application of reflective skills in professionally significant situations of the inclusive instruction of young learners.

The motivational-orienting stage aims to highlight the personal and professional significance of pedagogical reflection, build a positive disposition toward reflective activity, and develop an initial theoretical understanding of its essence, structure, and role in the primary school teacher's work within inclusive conditions. At this stage, the student realizes that the ability to analyze and correct one's own activity is a necessary condition for effective interaction with young learners with different educational capabilities and needs.

The content-operational stage focuses on building a system of knowledge about the techniques and procedures of reflective analysis and developing the corresponding skills: identifying the grounds for one's own pedagogical actions, relating intention and outcome, detecting difficulties and their causes, and designing ways to correct them. Mastering the operational composition of reflection is carried out using material that reflects the specific features of primary education and inclusive practice, ensuring the skills developed transfer to the real professional context.

The reflective-activity stage involves independently applying the developed reflective

skills in quasi-professional and practical situations in the inclusive instruction of young learners. At this stage, reflection takes on a regulatory function: the student conducts a self-analysis of their activity, evaluates the adequacy of the chosen strategies for adapting content and individualizing instruction for children with special educational needs, and, on this basis, corrects their professional actions.

The main organizational form for implementing the model is the elective course "Methods of formation of reflexive skills of primary school students in the conditions of inclusive education," which ensures the purposeful and systematic development of reflective skills; its trial implementation is envisaged as part of a subsequent formative experiment. The course content is structured according to the identified stages and integrates theoretical and practice-oriented training.

In the process of developing reflective skills, methods that activate the student's reflective activity are applied: the analysis of pedagogical situations and cases from the inclusive practice of the primary school; the keeping of a reflective journal that records the dynamics of professional self-reflection; the video analysis of lesson fragments; microteaching followed by individual self-analysis; and group reflection and supervision, which ensure that individual experience is related to external expert and collegial assessment.

The system of instructional organization forms is built with a predominance of practice-oriented and active forms-practical classes, training sessions, and the modeling of inclusive lesson fragments-which is conditioned by the requirements of the activity-based approach, according to which reflective skills are formed in the subject's own activity. The theoretical-orienting component, which ensures mastery of the initial understanding of the essence and structure of pedagogical reflection at the motivational-orienting stage, is implemented through interactive lecture forms (the problem lecture, the lecture-dialogue). The choice of interactive rather than traditionally monological lecture forms is determined by the personality-oriented approach, which presupposes the

student's subject position, the dialogic nature of instruction, and reliance on their subjective experience. The systemic approach ensures the subordination and coherent organization of these forms within a single process, along with their distribution across stages, with a regular transition from theory-orientings to practice-activity forms, and effectiveness of the model is ensured by a set of interrelated pedagogical conditions: the creation of a reflection-oriented educational environment that stimulates the making sense and self-assessment of professional activity; the engagement of students in practical activity in settings where children with special educational needs are taught; the systematic pedagogical support of reflective activity on the part of the instructor, ensuring a gradual reduction of external regulation; and the drawing on the prospective teacher's subjective experience as the initial basis for the unfolding of reflection.

The outcome component establishes the criteria-and-levels basis for assessing the formation of reflective skills that is built into the model. The criteria are aligned with the structure of reflective skills and include the motivational, cognitive, operational-activity, and evaluative-reflective criteria. Each criterion corresponds to a system of indicators: for the motivational criterion-an awareness of the value of reflection and the stability of interest in analyzing one's own activity; for the cognitive criterion-the completeness and systematic nature of knowledge about reflection, special educational needs, and ways of adapting instruction; for the operational-activity criterion-the formation of the skills of observing, interpreting, and restructuring pedagogical actions; and for the evaluative-reflective criterion-the adequacy of self-assessment and the capacity to correct one's activity. Based on how the indicators are expressed, the model differentiates three levels of reflective skill formation: reproductive, adaptive, and creative.

The reproductive level is characterized by unstable motivation for reflection and its perception as an external requirement; knowledge about reflection and special educational needs is fragmentary; the prospective teacher analyzes

their own activity superficially, primarily describing events without identifying their causes, and acts according to ready-made models, without restructuring their activity, based on analysis, to suit the needs of the individual child; self-assessment is inadequate or absent. This level corresponds to an orientation toward the formal inclusion of the child, that is, in effect, toward integration.

The adaptive level is characterized by a sustained interest in reflective analysis and an awareness of its professional value; knowledge about reflection and ways of adapting instruction is sufficiently complete and systematic; the prospective teacher not only describes but also interprets pedagogical situations, identifies difficulties, and, based on reflective analysis, consciously adapts their own activity to the needs of the child, drawing on the guidelines provided; self-assessment is generally adequate, though the ways of correction are not always determined independently.

The creative level is characterized by an internal need for reflection as a stable professional disposition; knowledge is complete, systematic, and consciously applied; the prospective teacher independently and critically analyzes their own activity, establishes cause-and-effect relationships, and, on this basis, designs and creatively restructures the educational process about the individual needs of learners, flexibly generating new solutions in situations of uncertainty; self-assessment is adequate and reflective, and the correction of activity is carried out independently. An indicator of this level is the capacity to ensure genuine inclusion.

The criteria-and-levels basis of the outcome component sets reference points for subsequent diagnostics. It makes it possible to track the dynamics of reflective skill development. In contrast, the feedback built into the model between the outcome component and the preceding components creates the conditions for adjusting the process.

Discussion. The results are consistent with contemporary research that recognizes reflection as a key factor in prospective teachers' professional development, while also refining and extending this research to the conditions of

inclusive education.

The developed model aligns with scholarly understanding that reflective skills constitute a component of primary school teachers' professional competence. Thus, Susanto, Rozali, and Agustina (2019), in constructing a model of the pedagogical competence of primary school teachers, included reflective ability among its basic constructs alongside pedagogical knowledge, emotional intelligence, and communication. Our model shares this understanding of the significance of reflection but differs in its subject, target audience, and context: whereas in the aforementioned work reflection acts as one of the elements of the broader competence of practicing teachers, in the proposed model reflective skills are an independent object of purposeful formation, the target audience is prospective teachers at the stage of university training, and the formation itself is oriented toward the specific tasks of the inclusive educational environment, which is not considered in that work.

The results also align with studies confirming the effectiveness of reflective practice in training prospective teachers. Honghuan Li (2025) showed that systematic reflective practice substantially contributes to the development of critical pedagogical skills and supports students' transition to the professional activity of a novice teacher. This conclusion reinforces the logic of the activity-based formation of reflective skills built into our model; at the same time, the aforementioned study is predominantly qualitative and narrative in nature and does not offer a coherent structural-component model, whereas in the present work reflective skills are formed within a systematically organized model with coordinated target, conceptual-methodological, content, procedural, and outcome components.

The level-based foundation of the proposed model draws on classical conceptions of the depth of reflection, according to which reflection develops from descriptive through dialogic to critical, and from a technical making sense of activity to a making sense of its value foundations (Hatton & Smith, 1995; Korthagen & Vasalos, 2005). The levels identified in the

model-reproductive, adaptive, and creative-correspond to this logic of the increasing depth of making sense of experience. The proposed model distinguishes itself by tying levels of reflection to the specific features of the inclusive environment and directly linking them to the prospective teacher's transition from an orientation toward the formal inclusion of the child to ensuring the child's full participation.

The results obtained supplement studies that establish a connection between reflective strategies and preparation for work with learners with special educational needs (Şerban & Hathazi, 2025), and they fit into the context of Kazakhstani studies that record a gap between declared inclusion and the actual practice of schools (Mamerkhanova et al., 2025). The proposed model thereby contributes to bridging the contradiction noted in the introduction, conceptually uniting the previously disparate areas-theory of pedagogical reflection and research on readiness for inclusive education-and substantiating reflection as a mechanism for the transition from integration to genuine inclusion.

Conclusion. The model for the formation of reflective skills in prospective primary school teachers within the conditions of inclusive education responds to the current requirements for the professional training of teachers, requirements driven by the gap between the normatively established principle of inclusion and the actual practice of primary schools, in which the instruction of children with special educational needs is often reduced to their formal inclusion without a restructuring of the educational process. Under these conditions, it is precisely reflective skills that act as the mechanism enabling the prospective teacher to move from an orientation toward the formal presence of the child to ensure the child's full participation, that is, from de facto integration to genuine inclusion.

In accordance with the stated aim, the model was not only developed but also theoretically substantiated: its underlying theories and methodological approaches were identified, the structure of the reflective skills to be formed was revealed, the stages, methods, and pedagogical conditions of their formation were designed, and the criteria-and-levels basis for assessing the outcome was established. The formulated research question concerning the structure and content of a model that ensures the transition from the reproductive assimilation of pedagogical knowledge to conscious, reflectively regulated activity in the inclusive environment was thereby resolved. The answer to it is a coherent model in which the target, conceptual-methodological, content, procedural, and outcome components are linked by a single logic, and in which reflection is substantiated as a system-forming mechanism that moves the training of the prospective teacher from the reproductive level to the creative level and ensures the transition from integration to genuine inclusion. The study thereby resolves the identified contradiction, conceptually uniting the previously disparate areas-the theory of pedagogical reflection and research on readiness for inclusive education.

Further research may be directed toward the empirical validation of the model in educational practice, including the development and implementation of the elective course as the main means of its realization, the conduct of a formative experiment, and the quantitative diagnosis of the dynamics of the formation of reflective skills according to the identified criteria and levels. It also appears promising to study the impact of the systematic formation of reflective skills not only on prospective teachers' readiness for inclusion but also on the development of the prospective teacher's related professional qualities-critical thinking, the capacity for self-analysis, and the adaptation of the educational process to the individual needs of learners.

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Exploring Factors Influencing the Development of Students' Reflective Skills in Artificial Intelligence-Supported Learning

Abstract

Introduction. The article examines the factors influencing students' reflective skills in AI-based learning in higher education. Artificial intelligence (AI) has become an important component of the digital transformation of education, providing opportunities to enhance efficiency, accessibility, and flexibility of learning. In this context, the development of students' reflective and metacognitive skills has become an increasingly important research area. The study *aimed* to identify key factors associated with students' reflective skills in AI-based learning environments and to empirically examine the relationships among these factors. **Methodology and Methods.** The study employed quantitative research design and Partial Least Squares Structural Equation Modeling (PLS-SEM). The sample comprised 234 students from Abai Kazakh National Pedagogical University and Kazakh National Women's Teacher Training University. The model included four factors: perceived usefulness of AI, perceived ease of use, AI usage, and AI feedback. The *results* revealed a weak positive relationship between perceived usefulness of AI and students' reflective skills, while perceived ease of use, AI usage, and AI feedback demonstrated weak negative relationships. These findings indicate that AI use alone does not ensure the development of students' reflective thinking. Effective integration of AI into higher education should therefore be supported by reflective tasks, critical thinking activities, and metacognitive strategies. **Scientific novelty.** The study empirically examines the relationships between AI-related learning factors and students' reflective skills, demonstrating the limited explanatory value of technology use alone and highlighting the importance of pedagogical and metacognitive conditions. **Practical significance.** The findings support the integration of reflective tasks, critical thinking, self-assessment, and metacognitive activities into AI-supported learning environments. The study provides a basis for developing pedagogically grounded approaches to the effective integration of AI technologies in higher education.

Keywords: higher education, artificial intelligence, reflective skills, digital education, AI-based learning, metacognitive skills, PLS-SEM analysis.

Introduction. Currently, the rapid development of digital technologies in higher education is introducing significant changes to the content and organization of the educational process (Mary, D., & Joyce, M., 2024). In particular, introducing artificial intelligence technologies into the educational system is considered one of the most important factors in modernizing the educational environment and increasing the efficiency, accessibility, and

quality of the learning process (Ayeni, O. et al., 2024).

Learning systems based on artificial intelligence allow students to form individual learning trajectories, personalize educational materials, and optimize educational outcomes (Ifraheem, S. et al., 2024). At the same time, AI technologies are expanding the intellectual capabilities of digital educational platforms (Kosaraju, D., 2022). This improves students'

learning motivation, participation in the learning process, and academic results (Peng, Q., 2024). The integration of artificial intelligence technologies into the educational system effectively offers new opportunities, such as distance learning, the creation of multimodal learning environments, and expanded access to educational services. Such changes will affect the sustainable development of the higher education system and lay the foundation for a digital education ecosystem (Buşu, A., 2024). However, the widespread use of AI-based learning environments also introduces new factors that contribute to the development of students' cognitive and metacognitive abilities.

In this context, students' reflective skills are particularly important. Reflection is considered one of the important cognitive mechanisms that allow students to analyze their learning activities, evaluate learning outcomes, and improve learning strategies in the learning process (Siminto et al., 2023). Studies have shown that reflective and metacognitive skills play an important role in improving learning outcomes and improving the quality of the educational process (Zang et al., 2021). Therefore, identifying the factors that contribute to students' reflective skill development in AI-based learning environments is a current area of pedagogical research. Recent empirical evidence indicates that the integration of artificial intelligence into learning activities can contribute to the development of higher-order cognitive processes, including reflective thinking, particularly when AI is embedded within purposeful instructional designs (Saritepeci, M., & Yildiz Durak, H., 2024). Recently, the number of scientific studies on AI in education has increased significantly. Researchers are considering the impact of AI technologies on the educational process in various directions. In particular, the possibilities of AI in the development of personalized learning systems, its role in the formation of intelligent learning platforms, and its impact on optimizing learning outcomes are being widely studied (Begum, I. 2024).

Research in the field of Artificial Intelligence in Education (AIED) also examines the

adaptive capabilities of learning platforms, the relationship between educational technologies and learning outcomes, and the usability of digital learning environments (Alenezi, F. Y., 2023). These studies suggest that intelligent learning systems can tailor the learning process to individual learners' needs. The role of metacognitive and reflective skills in AI-based learning environments has also been widely discussed in scientific research (Ouyang, Z., 2025). Some studies show that AI platforms can influence the development of students' self-regulation skills and active participation in the learning process (Abgaryan et al., 2023). At the same time, it is well known that the characteristics of digital learning environments affect students' motivation to learn, learning effectiveness, and reflective thinking skills. However, the exact mechanisms by which AI-based learning environments influence students' reflective skills have not yet been fully studied. Some studies suggest that this relationship may be mediated by indirect factors, for example, through mediating variables such as self-regulation, learning motivation, and engagement in the learning process. The development of AI in education is closely related to the international concept of Education 4.0. This concept aims to modernize the education system by integrating digital technologies and intelligent systems into the educational process. Studies show that AI technologies contribute to updating educational content, improving teaching methods, and digitally transforming the learning environment.

Reflective learning and metacognitive skills are considered to be important components of the learning process. Metacognitive skills allow students to monitor their own learning, plan learning strategies, and assess learning outcomes. Research has shown that AI-based learning systems can enhance students' metacognitive skills through learning analytics and feedback mechanisms. At the same time, digital educational technologies are considered one of the factors contributing to the development of students' reflective thinking. Such technologies provide an opportunity to effectively manage students' learning activities through data-based feedback, learning analytics,

and intelligent tools for teachers (Ceylan, M., & Mnzile, J. Y., 2025).

Although the studies reviewed above have examined the impact of AI technologies on the educational process from various angles, the specific factors that influence students' reflective skills in AI-based learning environments have not been fully explored. First, while many studies have focused on learning outcomes and learning effectiveness, the mechanisms underlying the development of reflective skills and their relationship with the structural features of the learning environment have not been sufficiently studied (Ray, S., & Ray, D., 2024). Second, the impact of AI-based learning environments on students' reflective thinking across different cultural and institutional contexts has been relatively underexplored. In this context, factors such as access to educational resources, digital infrastructure, learning culture, and academic ethics are important (Toyokawa, 2023). Third, it is not yet fully understood what the pedagogical impact of AI-based learning tools - chatbots, intelligent learning systems, and learning analytics - has on students' reflective thinking skills. At the same time, issues of data security and academic ethics in the use of such technologies are also important areas of research (Abdelmagid, 2024). In this regard, this study aims to systematically analyze the factors that affect students' reflective skills in AI-based learning environments and identify their interrelationships.

The study's theoretical significance is to explain the mechanisms underlying the development of students' reflective and metacognitive skills in AI-based learning environments. The results provide an opportunity to consider educational theories and the design of digital learning environments from an integrated perspective. The practical significance of the research lies in developing pedagogical recommendations for the effective use of artificial intelligence technologies in higher education institutions. The recommendations will enable curriculum updates, improved teaching methods, and learning environments that foster the systematic development of students' reflective skills. Thus, the results of the

study will help identify pedagogically effective ways to use artificial intelligence technologies in the higher education system and develop scientifically based recommendations aimed at developing students' self-regulation, critical thinking, and reflective skills.

Materials and Methods. *Research design.* This study employed a quantitative, cross-sectional, non-experimental research design aimed at identifying the factors associated with students' reflective skills in artificial intelligence-supported learning in higher education. The relationships among the latent variables were examined using Partial Least Squares Structural Equation Modeling (PLS-SEM).

PLS-SEM was selected for three reasons. First, the study is exploratory and prediction-oriented rather than strictly confirmatory, since the mechanisms linking AI-supported learning to the development of reflective skills have not yet been firmly established in the literature. Second, the research model contains five latent constructs measured reflectively by multiple observed indicators, which corresponds to the type of model for which PLS-SEM is intended. Third, PLS-SEM does not require the assumption of multivariate normality and performs robustly with moderate sample sizes, which makes it one of the most widely applied statistical approaches in social and pedagogical research.

Research model and hypotheses. The research model comprised four exogenous constructs and one endogenous construct. The exogenous constructs were Perceived Usefulness of AI (PU), Perceived Ease of Use of AI (PEOU), AI Usage in Learning (AIU), and AI-based Feedback (AIF). The endogenous construct was students' Reflective Skills (RS).

Perceived usefulness and perceived ease of use represent students' evaluative beliefs about AI as a learning tool, that is, the extent to which AI is seen as effective for completing learning tasks and as easy and clear to operate. AI usage reflects the behavioral dimension of the model, namely the frequency and regularity with which students draw on AI tools in their academic work. AI-based feedback captures the informational support students receive from AI

systems in the form of immediate responses, error identification, and improvement suggestions. Reflective skills, as the outcome construct, refer to students' capacity to critically analyze their own learning activity, evaluate learning outcomes, identify the causes of their errors, and improve their learning strategies.

On this basis, four hypotheses were formulated:

H₁ Perceived usefulness of AI is related to students' reflective skills.

H₂ Perceived ease of use of AI is related to students' reflective skills.

H₃ The intensity of AI usage in learning is related to students' reflective skills.

H₄ AI-based feedback is related to students' reflective skills.

All five constructs were specified as reflective, since within each construct the indicators are conceptually interchangeable manifestations of a single underlying concept and are expected to covary positively.

Participants and sampling procedure. The study was conducted at two higher education institutions in Kazakhstan: Abai Kazakh National Pedagogical University and Kazakh National Women's Teacher Training University. The institutions were selected purposively. Both are pedagogical universities, which means that the respondents are prospective teachers, and reflective competence is a core professional requirement for this group. This setting therefore allows the experience of future teachers with AI technologies to be examined in direct connection with the development of their reflective skills.

Participants were recruited through non-probability convenience sampling among students of the two universities. Participation was open to all students who were willing to complete the online questionnaire, and the final analytical sample consisted of 234 respondents. Respondents took part in the study voluntarily and submitted their answers through the online questionnaire.

The adequacy of the sample size was evaluated against two commonly applied criteria for PLS-SEM. According to the ten-times rule, the minimum sample size should be

at least ten times the largest number of structural paths directed at a single construct in the model; with four paths directed at Reflective Skills, the required minimum is 40 cases. According to the inverse square root method, a sample of 234 cases allows path coefficients of $|\beta| \geq 0.163$ to be detected at the 5% significance level with a statistical power of 80%. The sample obtained therefore satisfies both criteria, although it also implies that path coefficients smaller than this threshold should be interpreted with caution.

Measurement instrument. Data was collected using a structured self-report questionnaire developed for the purposes of this study. The instrument operationalized the five latent constructs of the research model through 21 observed indicators: Perceived Usefulness of AI was measured by four indicators (PU1–PU4), Perceived Ease of Use of AI by four indicators (PEOU1–PEOU4), AI Usage in Learning by four indicators (AIU1–AIU4), AI-based Feedback by four indicators (AIF1–AIF4), and Reflective Skills by five indicators (RS1–RS5). The full wording of the items is presented in Table 1.

The items measuring perceived usefulness and perceived ease of use were formulated in line with the established technology acceptance framework and adapted to the context of AI-supported learning. The items measuring AI usage and AI-based feedback were formulated to reflect the behavioral and informational dimensions of working with AI tools in academic tasks. The items measuring reflective skills were formulated in accordance with conceptualizations of reflective learning as the analysis of one's own learning activity, the evaluation of outcomes, the identification of the causes of errors, and the improvement of learning strategies.

All 21 items were rated on a five-point Likert scale ranging from 1 (completely disagree) to 5 (completely agree). All items were worded in a positive direction; no reverse-worded items were included in the instrument. This is methodologically relevant for the interpretation of the measurement model, since with uniformly positively worded reflective indicators, negative outer loadings are not theoretically expected and require verification of item coding.

Data collection procedure. Data was collected through an online survey. The questionnaire link was distributed among students of the two participating universities, and responses were submitted electronically. The introductory section of the questionnaire presented the aim of the study, explained the structure of the instrument and the response scale, stated that participation was voluntary, and informed respondents that the answers were collected anonymously and that there were no correct or incorrect responses. Completion of the questionnaire followed the respondent's informed consent. The collected responses were exported for statistical processing without any personally identifying information.

Data analysis. The collected data was analyzed using SmartPLS 4 software. Prior to model estimation, the dataset was screened for missing values, out-of-range values, and response patterns indicating inattentive answering. The consistency of item coding and of the direction of the response scale was also verified, since inconsistent coding of a uniformly positively worded scale is one of the known sources of negative indicator loadings in reflective measurement models.

The analysis followed the standard two-stage procedure for PLS-SEM, in which the measurement model is assessed first, and the structural model is interpreted only after the quality of measurement has been established.

Stage one: assessment of the measurement model. Indicator reliability was assessed through the outer loadings of the observed variables. Loadings of approximately 0.708 or higher were considered desirable, since at this level the construct explains more than 50% of the indicator's variance. Indicators with loadings between 0.40 and 0.708 were considered for retention only after examining their contribution to composite reliability, convergent validity, and content validity, while indicators with loadings below 0.40 were treated as candidates for removal or further examination. Internal consistency reliability was assessed using Cronbach's alpha, composite reliability, and rho_A. Convergent validity was assessed through the average variance extracted (AVE),

with values of 0.50 or higher indicating that the construct explains, on average, more than half of the variance of its indicators. Discriminant validity was assessed using the Fornell–Larcker criterion and the heterotrait–monotrait ratio of correlations (HTMT).

Stage two: assessment of the structural model. The structural model was evaluated by computing the path coefficients describing the relationships between the latent variables, corresponding to hypotheses H1–H4. Collinearity among the predictor constructs was examined through variance inflation factor values. The explanatory power of the model was assessed using the coefficient of determination (R^2) for the endogenous construct, which indicates the proportion of variance in students' reflective skills jointly explained by the four AI-related constructs.

Through this sequence of procedures, the study empirically examined the principal factors associated with students' reflective skills in artificial intelligence-supported learning and the interrelationships among them.

Ethical considerations. The study was conducted in accordance with the standard ethical principles governing research involving human participants, including the principles of voluntary participation, informed consent, anonymity, and confidentiality.

Before data collection, all participants were informed about the purpose of the study, the procedures involved, the approximate time required to complete the questionnaire, and the intended use of the collected data. Participation was entirely voluntary. Respondents provided informed consent prior to completing the online questionnaire and were free to decline participation or to discontinue at any stage without providing a reason and without any academic or other consequences.

Responses were collected anonymously. The questionnaire did not request names, contact details, identification numbers, or any other data enabling the identification of individual respondents, and no sensitive personal information was requested at any point of the survey. The confidentiality of the collected data was strictly maintained: the dataset was stored in a

protected form, accessible only to the authors, and was used exclusively for the research purposes described to participants. The results are reported solely in aggregated form, so that no individual response can be traced back to a particular respondent or to a particular group of

students within the participating universities. No incentives or rewards were offered for participation, and no relationship of academic dependence was used to encourage students to take part in the survey.

Table 1

Constructs and indicators used in the research model

Construct	Code	Statement
Perceived Usefulness of AI	PU1	Artificial intelligence makes it easier to complete learning tasks.
	PU2	Artificial intelligence improves my learning efficiency.
	PU3	Artificial intelligence helps me understand complex topics better.
	PU4	Artificial intelligence allows me to save time during the learning process.
Perceived Ease of Use of AI	PEOU1	Artificial intelligence tools are easy for me to use.
	PEOU2	I can quickly learn how to use artificial intelligence platforms.
	PEOU3	I rarely experience difficulties when working with artificial intelligence.
	PEOU4	The interface of artificial intelligence tools is clear and understandable.
AI Usage in Learning	AIU1	I regularly use artificial intelligence tools during my studies.
	AIU2	I frequently use artificial intelligence when completing assignments.
	AIU3	I use artificial intelligence to search for new information.
	AIU4	I use artificial intelligence to improve my academic performance.
AI-based Feedback	AIF1	Artificial intelligence provides immediate feedback on my assignments.
	AIF2	Artificial intelligence helps me identify my mistakes.
	AIF3	Artificial intelligence encourages me to review my work.
	AIF4	Suggestions provided by artificial intelligence help me improve my learning activities.
Reflective Skills	RS1	I critically analyze my own learning activities.
	RS2	I evaluate my results after completing a task.
	RS3	I try to identify the reasons for my mistakes during the learning process.
	RS4	I think about ways to improve my learning strategies.
	RS5	I systematically analyze my strengths and weaknesses in learning.

The indicators in Table 1 are based on assessing students' experiences using artificial intelligence tools in the learning process and their reflective learning abilities. The perceived usefulness of artificial intelligence refers to students' perceptions of these technologies as effective learning tools. The ease of use of artificial intelligence refers to how easily students use these technologies and how clear the interface is. The activity of using artificial intelligence refers to how often students use AI tools during their learning. At the same time, feedback from AI systems highlights the importance of the suggestions and corrections

students receive during learning tasks. Reflective skills assess students' ability to analyze their learning activities, evaluate learning outcomes, and improve learning strategies.

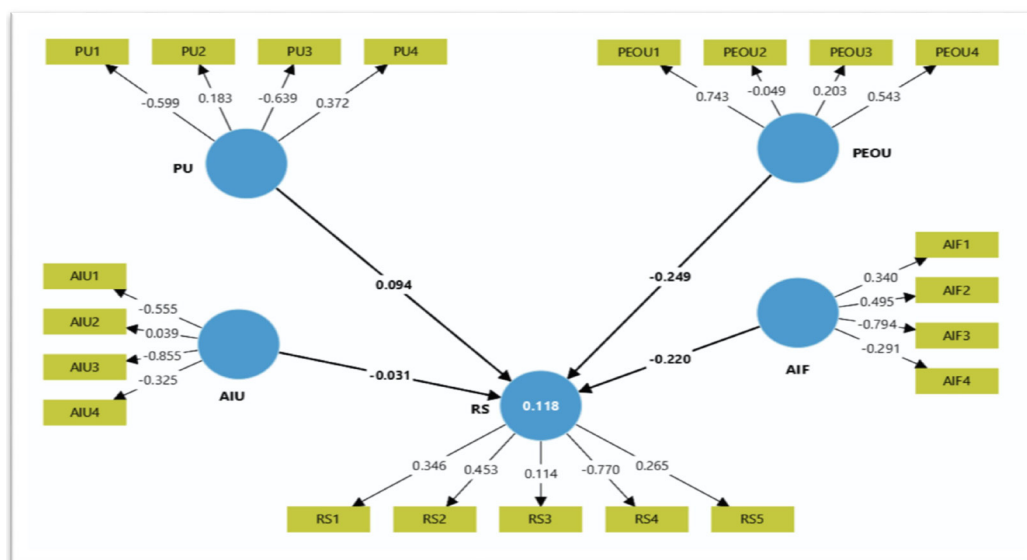
Results. In analyzing the research results, we assessed the relationships between artificial intelligence-based learning factors and students' reflective skills using Partial Least Squares Structural Equation Modeling (PLS-SEM). The research model considered four independent constructs. They were: Perceived Usefulness (PU) of artificial intelligence, Perceived Ease of Use (PEOU), AI Usage (AIU), and AI Feedback (AIF). The dependent variable was students'

reflective skills (RS). During model evaluation, we calculated indicator loadings, path coefficients between constructs, and indicators of the model's

explanatory power. We empirically analyzed the impact of artificial intelligence-based learning factors on students' reflective skills.

Figure 1

Structural model describing the impact of AI-based learning on students' reflective skills



In analyzing the research results, the relationship between artificial intelligence-based learning factors and students' reflective skills was assessed using a PLS-SEM structural equation model. The model considered four main independent variables. These were: Perceived Usefulness (PU) of artificial intelligence, Perceived Ease of Use (PEOU), AI Usage (AIU), and AI Feedback (AIF). The dependent variable was students' reflective skills (RS).

According to the structural model results, the explained variance coefficient for reflective skills was $R^2 = 0.118$. This means the factors in the research model explain about 11.8% of the variation in students' reflective skills. In social and pedagogical research, this indicator suggests the complexity of the phenomenon under study and the presence of numerous external factors that affect it. Therefore, the results suggest a role for the learning environment based on artificial intelligence in developing students' reflective thinking skills.

According to the model results, a positive relationship ($\beta = 0.094$) was observed between the perceived usefulness of artificial intelligence and students' reflective skills.

This result suggests that when students perceive artificial intelligence tools as useful for completing learning tasks, they pay closer attention to analyzing their learning activities, evaluating their results, and improving their learning strategies. Therefore, the functional effectiveness of artificial intelligence tools in the educational process may indirectly affect the development of students' reflective skills.

At the same time, the study results indicated that there is a weak or negative relationship between the factors of ease of use of artificial intelligence ($\beta = -0.249$), feedback based on artificial intelligence ($\beta = -0.220$), and activity in using artificial intelligence ($\beta = -0.031$) and students' reflective skills. These results clearly show that using artificial intelligence tools does not automatically increase students' reflective thinking, but in some cases may lead them to rely on ready-made answers. This, in turn, may contribute to underdeveloped skills in self-analysis and reflection on learning activities.

The results obtained during the study demonstrate the importance of pedagogical approaches when introducing artificial intelligence technologies into the educational process.

If artificial intelligence tools are used solely to obtain information or perform tasks, their impact on students' reflective thinking skills may be limited. Therefore, the use of artificial intelligence in the educational process should be combined with reflective tasks, elements of self-analysis, and pedagogical methods that develop critical thinking.

The scientific significance of the study results is closely related to the empirical analysis of the impact of an artificial-intelligence-based educational environment on students' reflective skills. At the same time, the study provides an opportunity to identify pedagogical conditions

for the effective use of artificial intelligence technologies in higher education. These results will inform the development of scientifically sound models for using artificial intelligence tools in training future teachers, as well as strategies to develop students' metacognitive and reflective competencies in a digital educational environment. Overall, the study's results provide important empirical data on the impact of an artificial intelligence-based learning system on students' reflective skills. At the same time, they provide a scientific basis for the effective pedagogical use of artificial intelligence technologies in higher education.

Table 2

Indicators of the research model constructs and indicators

Construct	Description	Indicators
Perceived Usefulness (PU)	Perceived usefulness of artificial intelligence in learning	PU1, PU2, PU3, PU4
Perceived Ease of Use (PEOU)	Ease of using artificial intelligence tools	PEOU1, PEOU2, PEOU3, PEOU4
AI Usage (AIU)	Level of artificial intelligence usage in learning activities	AIU1, AIU2, AIU3, AIU4
AI Feedback (AIF)	Feedback received through artificial intelligence tools	AIF1, AIF2, AIF3, AIF4
Reflective Skills (RS)	Students' reflective learning skills	RS1, RS2, RS3, RS4, RS5

Table 2 presents the latent constructs and their corresponding measurement indicators included in the proposed research model. The model was developed to examine the relationships between AI-related learning factors and students' reflective skills in AI-based learning environments. Each latent construct was operationalized using multiple indicators. Perceived Usefulness (PU) was measured using four indicators (PU1–PU4), Perceived Ease of Use (PEOU) was assessed using four indicators (PEOU1–PEOU4), AI Usage (AIU) was measured using four indicators (AIU1–AIU4), and AI Feedback (AIF) was assessed using four indicators (AIF1–AIF4).

Students' Reflective Skills (RS) were measured using five indicators (RS1–RS5).

The selected indicators represent students' perceptions and experiences of using AI technologies in the learning process, as well as aspects of their reflective learning. In particular, the model considers students' perceptions of the usefulness and ease of use of AI, their use of AI tools, the feedback they receive through AI technologies, and their reflective learning skills. These constructs and indicators provide the measurement basis for examining the relationships between AI-related learning factors and students' reflective skills.

Table 3

Measurement model: Indicator loadings

Construct	Indicator	Outer Loading
PU	PU1	-0.599
PU	PU2	0.183
PU	PU3	-0.639
PU	PU4	0.372

PEOU	PEOU1	0.743
PEOU	PEOU2	-0.049
PEOU	PEOU3	0.203
PEOU	PEOU4	0.543
AIU	AIU1	-0.555
AIU	AIU2	0.039
AIU	AIU3	-0.855
AIU	AIU4	-0.325
AIF	AIF1	0.340
AIF	AIF2	-0.495
AIF	AIF3	-0.794
AIF	AIF4	-0.291
RS	RS1	0.346
RS	RS2	0.453
RS	RS3	0.114
RS	RS4	-0.770
RS	RS5	0.265

Table 3 presents the outer loadings of the observed indicators on their corresponding latent constructs. In PLS-SEM, outer loadings are used to assess the extent to which individual indicators represent their respective constructs and provide an important basis for evaluating the measurement model. Indicator loadings of approximately 0.708 or higher are generally considered desirable because they indicate that the construct explains more than 50% of the indicator's variance. However, indicators with loadings between 0.40 and 0.708 may be retained after considering their contribution to composite reliability, convergent validity, and content validity. Indicators with loadings below 0.40 generally require removal or further examination.

The results presented in Table 3 demonstrate substantial variation in the outer loadings across the constructs. PEOU1 demonstrated the highest positive loading (0.743), indicating a relatively strong association with the Perceived Ease of Use construct. However, PEOU4 had a lower loading of 0.543, while RS2 demonstrated a loading of 0.453. These values indicate weaker indicator-level associations and therefore require further assessment within the measurement model. Several indicators demonstrated negative loadings, including PU1 (−0.599), PU3 (−0.639), AIU1 (−0.555), AIU3

(−0.855), AIF2 (−0.495), AIF3 (−0.794), and RS4 (−0.770). Other indicators demonstrated very low positive or negative loadings, including PU2 (0.183), PU4 (0.372), PEOU2 (−0.049), PEOU3 (0.203), AIU2 (0.039), AIU4 (−0.325), AIF1 (0.340), AIF4 (−0.291), RS1 (0.346), RS3 (0.114), and RS5 (0.265).

The prevalence of low and negative loadings indicates that the measurement properties of several indicators require careful examination before substantive conclusions are drawn from the structural model. In particular, negative loadings may result from reverse-worded indicators, inconsistent coding, or differences in the direction of the response scales. Therefore, the coding and wording of the indicators should be verified before interpreting these results. The measurement model should also be evaluated using internal consistency reliability and convergent and discriminant validity criteria, including Cronbach's alpha, composite reliability, rho_A, AVE, and HTMT. Overall, the results of the initial measurement model indicate that not all indicators demonstrate satisfactory relationships with their respective constructs. Consequently, the structural model findings should be interpreted with appropriate caution until the reliability and validity of the measurement model have been established.

Table 4*Structural model results indicators.*

Hypothesis	Path	Path Coefficient (β)
H ₁	PU $\rightarrow$ RS	0.094
H ₂	PEOU $\rightarrow$ RS	-0.249
H ₃	AIU $\rightarrow$ RS	-0.031
H ₄	AIF $\rightarrow$ RS	-0.220

Table 4 presents the results of the structural model, including the path coefficients associated with the hypothesized relationships between the latent constructs. The structural model was used to examine the relationships between AI-based learning factors and students' reflective skills.

The first hypothesis (H₁) examined the relationship between Perceived Usefulness (PU) of artificial intelligence and Students' Reflective Skills (RS). The path coefficient for PU $\rightarrow$ RS was $\beta = 0.094$, indicating a weak positive relationship. This finding suggests that students who perceive AI tools as useful for supporting their learning activities may demonstrate somewhat higher levels of engagement in analyzing their learning processes and evaluating learning outcomes. The second hypothesis (H₂) examined the relationship between Perceived Ease of Use (PEOU) and Students' Reflective Skills. The path coefficient for PEOU $\rightarrow$ RS was $\beta = -0.249$, indicating a weak negative relationship. This finding suggests that greater perceived ease of use was associated with lower levels of reflective skills in the present sample. However, this result should be interpreted cautiously, as the observed association does not by itself establish a causal relationship between ease of use and students' reflective skills. The third hypothesis (H₃) examined the relationship between AI Usage (AIU) and Students' Reflective Skills. The path coefficient for AIU

$\rightarrow$ RS was $\beta = -0.031$, indicating a very weak negative relationship. This finding suggests that the level or frequency of AI use was only weakly associated with students' reflective skills in the present research model. Thus, the frequency of AI use alone may not be sufficient to support the development of reflective learning processes. The fourth hypothesis (H₄) examined the relationship between AI Feedback (AIF) and Students' Reflective Skills. The path coefficient for AIF $\rightarrow$ RS was $\beta = -0.220$, indicating a weak negative relationship. This finding suggests that greater reliance on AI-based feedback was associated with lower levels of reflective skills in the present sample. However, the result should not be interpreted as evidence that AI feedback directly reduces students' reflective skills without considering the pedagogical context in which such feedback is used. Overall, the structural model results indicate that the relationships between AI-based learning factors and students' reflective skills are complex and multifaceted. The findings suggest that the presence or frequency of AI use alone may not be sufficient to support the development of reflective skills. Instead, the educational value of AI technologies may depend on how they are incorporated into pedagogical activities, particularly those involving reflection, self-assessment, critical evaluation, and independent reasoning.

Table 5*Coefficient of determination (R^2) indicator*

Endogenous Variable	R^2
Reflective Skills (RS)	0.118

Table 5 presents the coefficient of determination (R^2), which describes the variance explained by the endogenous variable

in the structural model. The R^2 indicator allows us to assess the degree of influence of the independent variables in the research model on

the endogenous variable, as well as the model's explanatory power. According to the PLS-SEM methodology, the R^2 value is considered an important indicator of the model's predictive and explanatory power.

The results showed that the R^2 value for Students' Reflective Skills (RS) was 0.118. This indicates that Perceived Usefulness (PU), Perceived Ease of Use (PEOU), AI Usage (AIU), and AI Feedback (AIF) jointly explained 11.8% of the variance in students' reflective skills. The remaining 88.2% of the variance

may be associated with other factors that were not included in the present research model. The relatively modest level of explained variance indicates that the AI-related constructs examined in this study represent only a part of the factors associated with students' reflective skills. This finding is consistent with the multidimensional nature of reflective learning, which may involve a broader range of cognitive, motivational, behavioral, and pedagogical factors beyond the AI-related variables included in the current model.

Table 6

Sample characteristics

Characteristic	Description
Sample size	234 respondents
Universities	Abai Kazakh National Pedagogical University; Kazakh National Women's Teacher Training University
Data collection method	Online questionnaire
Measurement scale	Five-point Likert scale
Analysis method	Partial Least Squares Structural Equation Modeling (PLS-SEM)
Software	SmartPLS 4

Table 6 presents the main characteristics of the study sample and the procedures used for data collection and analysis. The study included 234 students from Abai Kazakh National Pedagogical University and Kazakh National Women's Teacher Training University. The data were collected through an online questionnaire using a five-point Likert scale. The collected data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 4.

The participating universities specialize in teacher education and therefore provide a relevant context for examining students' experiences with artificial intelligence technologies in learning and their reflective skills. The sample consisted of students who participated in the study voluntarily and provided responses through the online questionnaire.

The quantitative design and PLS-SEM approach enabled the examination of the relationships between AI-related learning factors and students' reflective skills within the proposed research model. The structural model

included Perceived Usefulness (PU), Perceived Ease of Use (PEOU), AI Usage (AIU), and AI Feedback (AIF) as predictor constructs, while Students' Reflective Skills (RS) served as the endogenous construct.

Discussion. The structural model demonstrated a weak positive relationship between Perceived Usefulness (PU) and students' Reflective Skills (RS) ($\beta = 0.094$). This finding suggests that perceiving AI as useful may support students' engagement in learning activities, although its contribution to reflective skills is limited. Previous studies have also highlighted the role of perceived usefulness in the educational use of AI (Alenezi, 2023; Begum, 2024).

Perceived Ease of Use (PEOU) showed a negative relationship with Reflective Skills ($\beta = -0.249$). This result may indicate that highly convenient AI tools can reduce opportunities for independent analysis when students primarily use them to obtain information or complete learning tasks. Thus, technological convenience does not necessarily lead to deeper learning and reflection (Ayeni, 2024; Buşu, 2024).

AI Usage (AIU) demonstrated a negligible negative relationship with Reflective Skills ($\beta = -0.031$), indicating that the frequency of AI use alone does not automatically contribute to the development of reflective skills. Similarly, AI Feedback (AIF) showed a weak negative relationship with Reflective Skills ($\beta = -0.220$). The negative associations observed for perceived ease of use and AI-based feedback may indicate that technological convenience and automated support do not necessarily generate reflective engagement. This interpretation is consistent with recent experimental work showing that AI-supported learning can benefit students when it is accompanied by explicit self-regulation scaffolding and collaborative reflection (Tsai et al., 2025). Thus, the pedagogical value of AI may depend less on the mere availability of technology than on how learning activities require students to interpret, evaluate, and reflect on AI-supported outputs.

This may suggest that AI-generated feedback is more likely to support reflection when students critically evaluate and apply it rather than simply accept the provided responses (Ouyang, 2025; Toyokawa, 2023). The coefficient of determination ($R^2 = 0.118$) indicates that the four AI-related factors explain 11.8% of the variance in students' reflective skills. This relatively low explanatory value suggests that reflective skills are influenced by additional pedagogical, cognitive, and individual factors that were not included in the present model.

Overall, the findings indicate that AI technologies do not automatically develop students' reflective skills. Their educational value depends largely on how they are integrated into learning activities. Therefore, AI-supported learning should be accompanied by reflective

tasks, critical thinking, self-assessment, and metacognitive activities that encourage students to evaluate information and consciously reflect on their learning processes.

Conclusion. This study examined the relationship between AI-based learning factors and students' reflective skills in higher education. The findings indicate that the role of artificial intelligence in developing reflective skills depends not only on the use of technological tools but also on the way they are integrated into the learning process. The results demonstrate that perceived usefulness has a weak positive relationship with reflective skills, while perceived ease of use and AI-based feedback show negative relationships. AI usage demonstrates a negligible relationship with reflective skills. The relatively low explanatory power of the model ($R^2 = 0.118$) suggests that reflective skills are influenced by a broader combination of pedagogical, cognitive, and individual factors.

The practical implication is that higher education institutions should focus on the purposeful pedagogical integration of AI rather than on technology use alone. AI-supported learning should provide students with opportunities for critical evaluation, self-assessment, reflection, and metacognitive monitoring. Future research should examine additional factors, including students' metacognitive awareness, critical thinking, motivation, digital competence, and teacher support, using larger and more diverse samples. Overall, this study contributes to a better understanding of the relationships between AI-based learning factors and students' reflective skills. It provides a scientific basis for the purposeful and pedagogically informed integration of artificial intelligence technologies into higher education.

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Exploring the Formation of Global Competences in Pre-service Primary School Teachers

Abstract

Introduction. This paper explores the issues of the formation of global competences in primary school pre-service teachers. Developing primary school pre-service teachers' global competences is significant because they play a crucial role in laying the foundation for educating future specialists who contribute to the country's development. Thus, it is essential to form and develop pre-service teachers' global competences during their training at universities to equip them for future opportunities. *Methods and methodology.* Both theoretical and empirical methods were employed in this research. An adapted global competence scale survey was used to collect the data from pre-service primary school teachers. *Results.* The research revealed that pre-service primary school teachers are competent in theoretical knowledge but demonstrate limited ability to apply it in practice. *Scientific novelty.* Although many studies have examined global competence, its importance and formation cases have not yet been investigated on a scientific basis - *practical significance.* The present research concluded that universities' educational programs for pre-service teachers should include content aimed at forming and developing their global competences.

Keywords: global competence, primary school, pre-service teachers, formation, development.

Introduction. Globalization and ongoing societal changes require revising educational programs to prepare teachers who can work effectively in modern schools. In response, universities' educational programs must be updated to focus on developing pre-service teachers' global competences. Modern teachers should not be limited to imparting knowledge; they should also strengthen students' ability to overcome social, economic, and technological difficulties.

One key issue in university education programs for primary school teachers is developing pre-service teachers' global competences. Global competences are often linked to global education, which is becoming increasingly important in contemporary education. Global education is understood as a combination

of theoretical knowledge that explains and informs the essence and effects, and practical application that provides the development of global competences. Global competences combine knowledge and abilities that enable successful interaction in different environments. Developing pre-service teachers' global competences enhances their understanding of diverse international processes, thereby contributing to the cultivation of critical thinking and tolerance. Therefore, university teacher training programs should include pedagogical approaches that develop the global competences of pre-service primary school teachers.

Developing global competencies among professionals is essential, as it enhances their competitiveness in the international labor market. Developing these competences is significant for

teachers, as it creates opportunities to prepare a young generation for active participation in the global world. It is important to introduce primary school students to the features of other nationalities and teach them to connect with people from other countries. For instance, primary school teachers play an important role in primary school children's understanding of global processes, respect for cultural diversity, and awareness of their responsibilities as citizens of Kazakhstan and members of the global community. Thus, theoretical understanding and empirical research into the formation of teachers' global competences, as well as the conditions and ways of their development, are particularly significant.

In addition, scientific research shows that secondary schools and higher education frequently address global competence, whereas primary school education and primary school teachers' training remain insufficiently studied. The lack of a clear methodological approach, assessment criteria, and conditions to support teachers' professional development to improve the quality of modern primary education demands thorough scientific exploration. Studying this topic makes it possible to define future primary school teachers' global competence formation level and identify the pedagogical conditions that support professional development. This research aims to identify future primary school teachers' global competence formation level and provide recommendations to support its development.

Understanding global education is essential for fostering the development of global competence. The concept "global competence" was introduced in International Education in 1988 (Leal et al., 2022). Global education is a necessary approach that enhances global relations and intercultural competence; it strengthens skills, knowledge, and attitudes, which are needed for dealing with different perspectives. Researchers highlight the importance of global education for intercultural communication. El-Kafafi (2025) noted that global education plays a tremendous role in building resilience, understanding, and respect for intercultural differences. Reimers (2020)

underscored the significance of global education in solving various global problems related to climate change, geopolitical problems, and many others. Furthermore, global education was identified as crucial for addressing these complex issues, which require both global knowledge and competencies.

Global education opens opportunities to form and develop global competences (Majewska, 2023). Global competences include knowledge and skills needed to comprehend, develop, and contribute to international communities. They form the basis for lifelong learning necessary in responding to global alterations. Global competences encompass the knowledge and skills needed to understand, engage with, and contribute to international communities. They form the foundation for lifelong learning, which is essential in responding to ongoing global changes.

Different definitions of the term "global competences" are given in the scientific literature. Hunter et al. (2006) considered global competence as a practical tool, emphasizing that it is a set of knowledge and abilities to differentiate cultural differences when interacting with people from other nationalities. This explanation strengthens the role of cultural understanding in global competence and offers precise recommendations for teaching methods. According to Li (2013), global competence is the capacity to comprehend global events and cultural norms outside of particular subjects or specialties, allowing for productive contact, communication, and group work in another cultural environment. Global competences are described as a body of awareness of regions, cultures, and global questions, and they are also abilities to be engaged with in a global environment (Rizvi & Lingard, 2009). The concept of global competences includes the combination of local and global knowledge, comprehension, and the capacity (Parmigiani et al., 2022).

The formation of global competences in teachers is crucial in modern education. It is determined by an awareness of the challenges of the times and the selection of competencies in an educational environment related to life

in a global community (Balitskaya, 2022). This selection was influenced by several interconnected and interdependent factors, including:

- the need to focus on the future of the entire global community;
- the specific nature of socioeconomic development of modern society;
- the increase of general skills which are related to personal qualities significant in any profession;
- modification of all life spheres;
- necessity of change of content of education and seeking a balance between subject-based and meta-subject-based education;
- the search for new approaches to the socialization of schoolchildren.

Educational authorities suggest that school curricula should contain content aimed at the formation and development of global competences. In this regard, experts in the educational sphere constantly urge students to enhance global competences in the interconnected world (Rizvi & Lingard, 2009). Ying et al. (2025) advise that the curriculum includes global competencies, which include knowledge development for global involvement and a global civic mindset. These materials help gain knowledge and skills needed for effective participation in the global world. These skills provide opportunities to successfully interact in the international community. The importance of global competences was discussed in the global scholarly circulation. For example, Köş and Celik (2023) noted that educational programs should align with global realities. Karanikola et al. (2022) observed that global competence encompasses a wide range of concepts and values that are necessary to collaborate, communicate, and work toward the welfare of both local and global competences.

Global competences of teachers are developed through different approaches. Wu (2023) explored how inquiry-based learning fosters teachers' global competences; the study demonstrates that teachers could improve their abilities needed to critically analyze local and global educational issues and power discourses.

Crawford et al.'s (2020) research revealed how an Instructional Design course could

contribute to increasing students' global competences; the study argues that in prioritizing global competence, it is essential to accelerate students' progress toward teaching global competence. Zhang et al. (2024) compared how a special program contributed to the development of in-service and pre-service teachers' global competences; their research found that the program impacted the development of global competences differently. The program positively influenced in-service teachers' ICT competences, while professional guide and robust knowledge were effective in strengthening their global competences.

The review of scientific literature made it possible to discover that, despite extensive research on global competences of teachers, the training of pre-service teachers has not been sufficiently investigated. Pre-service teachers lack the professional orientation needed to navigate the global changes sweeping Kazakhstan and other countries. For instance, in the design of training programs for future primary school teachers, insufficient consideration is given to globalization and its impact on education, and the development of teachers' global competencies is largely overlooked. This condition necessitates a realistic analysis of the objective state of affairs and a fresh look and assessment of the training requirements for primary school teachers called upon to work in the 21st century. Thus, investigating the level of pre-service teachers' global competences and providing recommendations for their development would help to fill this research gap.

Materials and Methods. Research Design. The study employed a cross-sectional survey design aimed at determining the level of formation of global competence among pre-service teachers. To collect the empirical evidence, the study adapted the global competence scale developed by Liu et al. (2020) to the context of teacher education in Kazakhstan.

Instruments. The instrument used for measuring pre-service teachers' global competence was a survey comprising 25 closed-ended questions and one open-ended question. Five of the closed-ended items collected demographic data, while the remaining 20 statements were

devoted to the assessment of global competence. Respondents indicated their level of agreement with each statement on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

The statements covered four components of global competence: global knowledge, global skills, global settings and values, and global activeness and readiness for action. The overall level of global competence was determined on the basis of total scores, which were classified into three levels: high, middle, and low. The open-ended question invited respondents to describe how they understand the role of global knowledge, skills, and values in their future professional career.

Participants. The respondents were students enrolled in various pedagogical majors at both bachelor's and master's levels. In total, 131 students from four universities took part in the research: Alikhan Bokeikhan University, L. N. Gumilyov Eurasian National University, Shakarim University, and Abai Kazakh National Pedagogical University. The distribution of participants across the universities is presented in Table 1.

Procedure. The survey was disseminated through a Google Form. Data collection lasted two weeks, a period determined by the

students' availability and the time required to obtain signed consent forms. Respondents were informed about the aim of the research, and participation was voluntary (Dörnyei, 2007).

Data Analysis. The collected data were processed using quantitative and qualitative methods. The internal consistency of the instrument was assessed using Cronbach's alpha coefficient, with $\alpha \geq .70$ adopted as the threshold for sufficient reliability; the obtained value met this criterion, confirming that the twenty statements reliably measured the construct of global competence.

Descriptive statistics - minimum, maximum, mean, and standard deviation - were computed for each statement and for each of the four components of global competence. Inferential testing was not performed, as the aim of the study was descriptive rather than comparative.

Responses to the open-ended question were examined through thematic analysis. The answers were read repeatedly, coded inductively, and grouped into categories on the basis of recurring semantic units; the resulting codes were then consolidated into broader themes, which are presented in Table 4 together with illustrative responses. The qualitative findings were used to contextualize and clarify the quantitative results.

Table 1

Information about students' universities

Universities	Number of students
Alikhan Bokeikhan University	38
L.N. Gumilyov Eurasian National University	37
Shakarim University	21
Kazakh National Pedagogical University named after Abai	35

Respondents were students in pedagogical majors such as pedagogy, mathematics, English, geography, Kazakh language, biology,

and IT teaching. Table 2 demonstrates the data on respondents' majors.

Table 2

Information about respondents' specialties

Majors	Number
Pedagogy	25
Mathematics	16

English	25
Geography	17
Kazakh language	15
Biology	15
IT	18

The data collection process lasted two weeks due to students' availability and the time required to sign the consent form. The respondents were informed about the aim of the research, and their participation was voluntary (Dörnyei, 2007). The majority of respondents were female (n=103), while the remaining respondents were male (n=28). This is explained by the fact that relatively few male students prefer pedagogical specialties. Respondents' ages ranged between 18 and 35 years. The presence of age 35

indicates the sample included master's students as well. 111 bachelor's students and 20 master's students participated in our survey.

Data Analysis. The collected data were processed through quantitative methods. To assess the reliability of the survey, Cronbach's alpha was calculated. A value of $\alpha \geq 0,70$ was considered a sufficient level of reliability, confirming that all statements measured global competences. For open-ended questions, a thematic analysis was conducted.

Results. The research revealed the following findings. The data are given in Table 3.

Table 3

Descriptive Statistics of the survey results

Statements	Min	Max	Mean	Standard Deviation
I Global knowledge				
I have a basic understanding of global problems (climate change, migration, inequality)	18	35	26,2	7,09
I understand how global processes influence a system of education	19	35	26,2	5,46
I am aware of the cultural, social, and educational features of different countries	17	38	26,2	9,28
I understand interactivity between local and global events	17	35	26,2	6,68
I understand the meaning of global competences in teachers' professional activity	19	35	26,2	5,98
II Global skills				
I can analyse the information of different cultural and international positions	21	33	26,2	5,27
I am able to critically analyse global events and activities.	23	28	26,2	1,94
I can effectively interact with representatives of other cultures	21	31	26,2	4,07
I am ready to use an international experience in my future pedagogical practice	18	38	26,2	6,76
I can work in a multinational and multicultural environment	23	28	26,2	1,94
III Global settings and values				
I respect cultural diversity	15	35	26,2	8,52
I am open to dialogue with people of other outlooks and cultures	18	31	26,2	4,62

I think it is important to form global competences of schoolchildren	10	39	26,2	10,67
I understand my responsibility as a future teacher in the global society	19	35	26,2	5,98
I strive to develop tolerance and mutual understanding in the educational environment.	17	35	26,2	6,68
IV Global activeness and readiness for actions				
I am ready to include global themes in the educational process	21	33	26,2	5,27
I am interested in participating in international programmes	15	33	26,2	7,30
I strive for consistent self-development in the sphere of global education	17	35	26,2	6,68
I am ready to use digital technologies for international interactivity	21	33	26,2	5,27
I think that I am ready for work in the conditions of a globalized world	18	33	26,2	5,46

The first block of the survey statements revealed that respondents' global knowledge mean is average ($M=26.2$). Respondents are familiar with different features of other countries, such as culture, social life, and education. However, their knowledge and skills should be enhanced. The second block findings indicate that respondents demonstrate moderate spread, which means that there are differences in the ability to integrate and analyze international and cultural data. The low variability means that respondents have common confidence in international and polycultural work. The third block results indicate that respondents are at an average level of value-oriented

competence, which means there is a need for further development of an understanding of the importance of global competences.

The fourth block findings demonstrate that respondents are at an average level of work in the globalized world. The data emphasize the need for practice-oriented work to increase respondents' professional skills in the international context. Moreover, the survey included one open-ended question. The question "How do you understand the role of global knowledge, skills, and values in your future career?" revealed the following answers. According to the answers, a thematic analysis was conducted, and Table 4 demonstrates these findings.

Table 4

A thematic analysis of the answers

Themes	Quotes
Global knowledge	Inclusion of global themes into educational disciplines will make teaching more effective; Comprehension of interconnections between local and global processes is needed for a future teacher; Studies on international educational experience contributes increase in the quality of teaching; Education should be focused on the international environment
Intercultural competence	International educational experience contributes to the improvement of education quality. Global context makes it possible to understand modern problems better. Respect for representatives of different cultures increases the quality of education. The ability to work in a multicultural environment is an important professional skill. Tolerance-based teaching should be the main priority in modern education. Simple human relations are the key to a successful career.

Digital technologies	Digital technologies expand international interethnic possibilities. Teaching online makes it easier to build global educational connections. Virtual academic mobility can be an alternative to traditional mobility as well. Use of international digital resources increases the enthusiasm of students. Digital literacy is an obligatory skill for teachers.
Language Proficiency	Knowledge of foreign languages is important for professional success; English is a necessary tool for both academic and professional needs. Foreign languages contribute to success in international relations. Knowledge of foreign languages will contribute to learning specific disciplines from different points of view. Proficiency in foreign languages will enhance international connections with experts.
Professional Development	Global competence opens opportunities for professional competence development. Global competence enhances students' critical and creative thinking. Global competence contributes to diverse learning styles. Global competence helps to connect with international experts who can guide students when they become specialists. Global competence prepares students for global jobs.

Table 4 summarizes five key themes from respondents about global competence in education. Overall, it shows that effective teaching and professional growth increasingly depend on integrating global knowledge, intercultural competence, digital technologies, language proficiency, and continuous professional development. Respondents emphasize that understanding global and local interconnections, working respectfully in multicultural settings, and using digital tools expand educational opportunities and improve quality. Foreign language skills, especially English, are seen as essential for international communication and academic success. Together, these themes suggest that modern education should prepare teachers and students to operate confidently in a globalized, interconnected, and technology-driven environment.

Ethical Consideration. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and the Law of the Republic of Kazakhstan “On Personal Data and Their Protection” (No. 94-V of 21 May 2013, as amended). The research was limited to a non-interventional online questionnaire survey of adult university students; it involved no medical, clinical, or experimental procedures, no deception, and no collection of sensitive personal data. Under the institutional regulations in force, studies of this type do not require review by a formal ethics committee.

Participation was entirely voluntary. Before completing the questionnaire, respondents were informed of the aims of the study, the procedure for working with the instrument, the approximate time required, and the intended use of the data for research purposes only; each participant signed a consent form prior to inclusion. Respondents were informed that they could decline to participate or withdraw at any stage without giving reasons, and that this would have no effect on their academic assessment or their relationship with the teaching staff. No incentives were offered for participation.

The questionnaires contained no names, student identification numbers, or contact details. Only aggregated demographic characteristics were recorded (university, major, degree level, gender, and age), which do not permit the identification of individual respondents. All data were stored on a password-protected device accessible only to the research team and are reported exclusively in aggregated form. Excerpts from the open-ended responses are presented without any details that would allow individual participants to be identified.

Discussion. The data revealed from the survey indicate that the level of formation of global competences of pre-service teachers of primary schools is not uniform, and these results are consistent with trends inherent in the modern educational space. The first block of statements revealed that our respondents' global

knowledge level is average; they are aware of the cultural, social, and educational peculiarities of other countries. However, the findings indicate that they have overall theoretical knowledge, but they lack its application. According to OECD (2018), students should not only gain theoretical knowledge, but they should also be able to apply this knowledge in practice.

The findings of the second block of statements demonstrated that there are some differences in the responses given by our respondents in terms of their abilities in integrating and discussing international and cultural data. We conclude that the mean spread of the responses indicates that respondents' cognitive skills are not enhanced uniformly. Moreover, the revealed low variability shows that students have a positive attitude, and they believe that they can work in an international and multicultural community. Deardorff (2006) considered this issue and emphasizes that the foundation of cognitive skills is values and attitudes, and our results are consistent with his proposed intercultural competence model.

The findings revealed from the third block of our survey indicate that respondents' competences related to values are at an average level. These results indicate that future primary school teachers comprehend the importance of global competences; however, this comprehension needs more clarification and study. According to UNESCO (2017), in *A Guide for Ensuring Inclusion and Equity in Education* Concepts, global educational values are the basis of global competences; thus, an understanding of the following values, such as responsibility, tolerance, and global interdependence, should be formed systematically.

The findings of the fourth block demonstrate that respondents' readiness for the global world is formed at an average level as well. These data indicate that universities' educational teaching programs lack practice-oriented objectives that are focused on the development of future primary school teachers' abilities to work in the international context. Darling-Hammond (2015), in his research, emphasized that to develop global competences, it is necessary to incorporate teaching models that combine

theory and practice into the educational process.

The open-ended question results demonstrate that participants' responses were concentrated around five topics, such as global knowledge, intercultural competence, digital technologies, language proficiency, and professional development. The revealed responses mean that the participants have knowledge, and they understand the necessity of global competences, but they lack the skills to apply this knowledge in practice. In our view, it is necessary to incorporate teaching models aimed at the formation of global competences of primary school teachers into university educational programs.

The findings of our research justify that it is important to develop global competences of future primary school teachers, and they should be developed via systematic, practice-oriented, and innovative methods. Moreover, the revealed data indicates the necessity of forming primary school teachers' global competences purposefully and structurally. The models aimed at students' global competences formation should be integrated into all educational programs of future teachers. We believe that linking educational disciplines' content with global content, using different teaching methods based on intercultural interaction, and introducing international academic practices such as virtual mobility, joint projects, and online interactions with foreign specialists can be beneficial. These methods improve future primary school teachers' critical thinking abilities regarding global issues and their ability to interact effectively in an international and multicultural society.

Conclusion. The formation of global competences of pre-service teachers is an important pedagogical issue. Exploring the level of formation of pre-service teachers helps reveal data on the readiness and the conditions for effective participation in the globalized world, as they play a great role in laying the foundation for future specialists capable of working in the future job market. The research conducted justified the necessity of the study in this field and identified that primary school pre-service teachers' level of global competences

is at an average level. The participants of the research survey understand the need for global competences; they have theoretical knowledge; however, they lack the skills to apply that knowledge in practice. Thus, universities' educational training programs should include modules focused on developing students' global competences.

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Formation of Research Culture in Future Educational Psychologists through Media Resources

Abstract

Introduction. Contemporary requirements for the professional practice of educational psychologists presuppose the ability to analyze scientific information, reflectively interpret professional experience, and make evidence-based decisions grounded in verified knowledge. Media resources, which occupy a central place in the information environment of students' professional development, are examined in this study as a potential means of fostering the research culture of future educational psychologists. **Methodology and Methods.** A pilot survey was conducted among 41 fourth-year students enrolled in the degree program 6B01101 Educational Psychologist, using an original questionnaire comprising four closed-ended questions. Quantitative data analysis was applied. **Results.** It was found that fewer than half of the respondents understood research culture as a broad professional characteristic. The overwhelming majority of students, 97.6%, assessed the contribution of university-level training to its development as insufficient. Media resources are perceived by students primarily as a technical tool for information retrieval, while academic databases remain the least utilized among all types of media resources. **Scientific Novelty.** The theoretical foundations of developing research culture in future educational psychologists through media resources have been examined. **Practical Significance.** The results of the pilot survey identified the baseline level of readiness among future educational psychologists to develop research culture through media resources and may serve as an empirical basis for further research in this area.

Keywords: research culture, future educational psychologist, media resources, professional training.

Introduction. The contemporary system of higher pedagogical education is under pressure from educational practice, which demands of graduates not only mastery of subject knowledge, but also the capacity to independently acquire, critically evaluate, and apply scientific knowledge within a constantly evolving professional environment. Research culture (Moran, 2020) has emerged at this stage as one of the priority characteristics of professional training, defining a specialist capable of acting not by imitation of established patterns, but on the basis of evidence-informed decisions. Research culture constitutes (Nosek, 2015) an integrative personal formation, expressing a subject's stable readiness and capacity for scientifically grounded understanding of professional reality.

It presupposes command of the methodological apparatus of inquiry, the ability to work with scholarly sources, to construct an evidential logic of professional judgments, and to reflectively interpret one's own practice. Within the international scholarly tradition (Dewey, 1933; Joyce, 2009; Schön, 1983), research culture is conceptualized through the category of reflective practice: D. Schön establishes the specialist's capacity to interpret professional experience through the lens of scientific knowledge as a fundamental characteristic of the competent practitioner, whereas J. Dewey regards the inquiring disposition as an indispensable condition of genuine professional thinking. In the works of B. Joyce and M. Weil, the research culture of the educator is associated

with the mastery of instructional models that involve the systematic study of pedagogical reality and the reflective processing of the data obtained. Research culture is not reducible to a sum of methodological knowledge; rather, it characterizes the professional stance of the individual and their capacity to perceive professional reality as an object of systematic inquiry.

The significance of research culture in contemporary conditions is determined by the fact that a specialist who lacks it inevitably reproduces outdated or non-evidence-based practices and makes professional decisions on the basis of everyday experience rather than verified knowledge. A well-developed research culture ensures professional resilience: it enables the specialist to navigate the body of scientific data, to critically evaluate information, and to adapt theoretical concepts to the specific conditions of their work. At the normative level, this significance is enshrined in the European Commission report *Supporting Teacher Competence Development for Better Learning Outcomes* (European Commission, 2013), which includes research competence in the core list of professional characteristics of the educator and regards the capacity for evidence-based justification of pedagogical decisions as a criterion of professional maturity.

With respect to future educational psychologists (Mamytbayeva, 2024), this requirement carries particular weight, owing to the specific nature of their professional practice. The object of the educational psychologist's professional attention is the psychological wellbeing, development, and socialization of children and adolescents - subjects whose psychological states require precise diagnosis rather than intuitive assessment. Diagnostic errors arising from methodological incompetence can cause real harm to a child's development, which makes research culture a guarantor of professional safety and ethical responsibility. Psychological science is, moreover, one of the most dynamically advancing fields of knowledge: methodological approaches, diagnostic instruments, and corrective techniques are regularly revised in light of new

empirical findings. A student who lacks research culture is deprived of the capacity to track these changes and to update their professional toolkit in a timely manner. The professional practice of the future educational psychologist involves the design and justification of psychological and pedagogical programs, participation in the monitoring of the educational environment, and the expert evaluation of pedagogical situations - all of which require the ability to design applied research, analyze its results, and formulate evidence-based recommendations. It is precisely during the period of university training (Pratt, 1999) that foundational professional dispositions are established and one's relationship to knowledge as such is formed: research culture developed at the stage of study becomes a stable component of professional self-awareness, shaping the character of subsequent professional development throughout the entire career.

The recognition of research culture as a key professional quality (Gemmell, 2010) of the future educational psychologist naturally raises the question of the pedagogical means by which it may be developed - and among these means, media resources occupy a distinctive place. The contemporary student receives the overwhelming majority of professionally relevant information from digital sources: electronic libraries, scholarly databases, educational platforms, and professional online communities. Media resources constitute the environment within which the future specialist's professional formation unfolds, and pedagogically organized engagement with this environment fits organically into the logic of research culture development, since it reproduces the actual conditions of future professional practice (Berduygina, 2020). Media resources provide access to primary scholarly sources, peer-reviewed journals, preprints, international databases such as Scopus and Web of Science, as well as diverse formats for the visualization of scientific knowledge. Working with these resources stimulates active rather than passive information consumption: searching, structuring, comparing sources, and identifying the methodological foundations of published research. Digital tools - video lectures, researcher

podcasts, interactive analytical platforms - allow the student to return to scholarly content repeatedly, to engage with it across different contexts, and to compare authors' positions, thereby creating conditions for the development of a reflective relationship to knowledge. The opportunity to engage with current scholarly debates in real time and to participate in professional online communities cultivates in the future educational psychologist a sustained cognitive interest - the affective foundation without which research culture remains a formal rather than a genuine professional attainment. Media literacy - the capacity to critically engage with and productively use the media environment - is itself a component of the educational psychologist's professional competence, given that their practice involves digital tools for diagnosis, counseling, and educational outreach (Erstad, 2010). The development of research culture through media resources thus addresses a compound objective, simultaneously advancing both the student's research skills and their media competence.

At the same time, the question of the extent to which future educational psychologists are genuinely prepared to develop research culture through media resources (Cao, 2017) remains insufficiently examined at the empirical level. Students' readiness for this process (Semenog, 2020) - their awareness of scholarly media resources, their experience of working with them, their motivation for research activity, and their self-assessment of their own research skills - constitutes the necessary baseline for any pedagogical effort in this direction. Identifying the current level of this readiness through a pilot survey will make it possible to determine students' starting positions, to reveal the gaps and resources upon which purposeful work on developing the research culture of future educational psychologists can draw, within the conditions of the contemporary media environment.

Materials and Methods. *Research Design.* The empirical foundation of the study comprised a pilot survey aimed at identifying future educational psychologists' conceptions of the nature of research culture, assessing

the conditions for its development within the process of professional training, and examining students' attitudes towards media resources as a means of its cultivation.

Participants. The study involved 41 fourth-year students enrolled in the degree program 6B01101 Pedagogy and Psychology. The selection of this category of respondents was determined by the fact that fourth-year students possess sufficient body of professional knowledge and academic experience to enable them to make informed assessments of the conditions for research culture development at university. The sample was exhaustive: all students of the relevant year and program were invited to participate.

Instrument. The instrument used for empirical data collection was an original questionnaire entitled "Future Educational Psychologists' Readiness to Develop Research Culture through Media Resources", comprising four closed-ended questions. The questionnaire encompasses three sequential thematic blocks: students' understanding of the nature of research culture in the educational psychologist's profession; their assessment of the degree to which it is developed within the context of university professional training; and their attitudes towards media resources as a means of its cultivation, together with the actual patterns of their use in academic activity. The closed-ended format of the questions ensures comparability of responses and the feasibility of quantitative data processing. The survey was conducted in person during a scheduled class session.

Data Analysis. The data obtained were subjected to quantitative analysis: for each question, the number of respondents who selected each response option was determined, along with its proportional share as a percentage of the total number of survey participants. The survey results are treated as pilot findings and do not claim representativeness with respect to the general population; their purpose is to yield preliminary empirical material recording the baseline level of future educational psychologists' readiness to develop research culture through media resources.

Ethical Consideration. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and the relevant national regulations on research involving human participants. The research was limited to an anonymous, non-interventional questionnaire survey of adult university students; it involved no medical, clinical, or experimental procedures, no deception, and no collection of personally identifiable or sensitive data. Under the institutional regulations in force, studies of this type do not require review by a formal ethics committee.

Participation in the study was voluntary, and the anonymity of respondents was guaranteed. Prior to completing the questionnaire, students were informed of the purpose of the study, the procedure for working with the instrument, and the intended use of the data for research purposes only. Respondents were informed that they could decline to participate or withdraw at any point without giving reasons, and that this would have no effect on their academic assessment or their relationship with the teaching staff. No incentives were offered for participation.

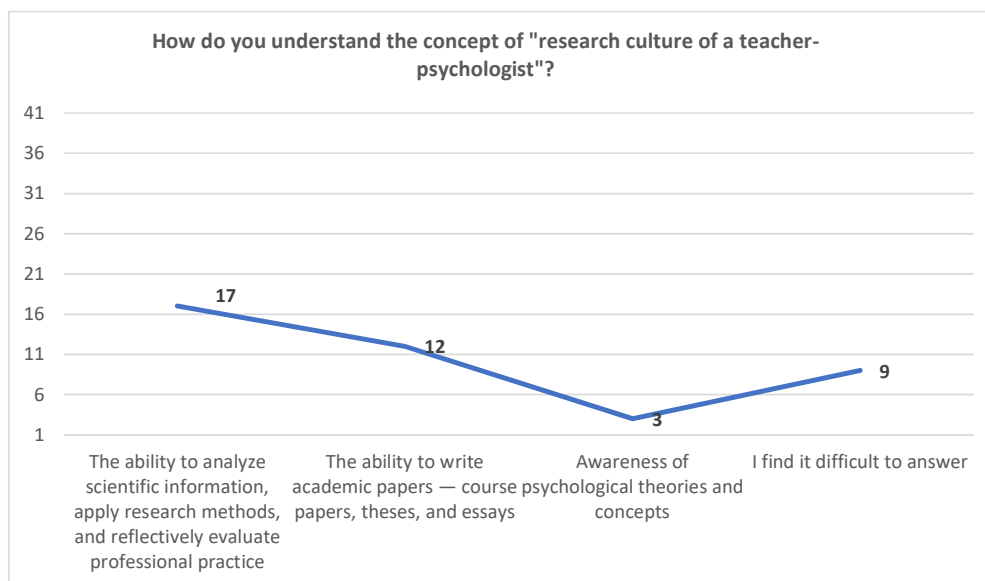
The questionnaires contained no names, student identification numbers, or any other identifiers. All responses were stored on a password-protected device accessible only to

the research team and are reported exclusively in aggregated form.

Results. Analysis of responses to the first questionnaire item, which was designed to identify students' understanding of the nature of research culture in the educational psychologist's profession, revealed that the majority of respondents - 17 individuals (41.5%) - associate research culture with the ability to analyze scientific information, apply research methods, and reflectively interpret professional practice, which corresponds to the scholarly content of the concept. At the same time, 12 students (29.3%) reduced research culture to the ability to write academic papers, 9 respondents (21.9%) were unable to provide an answer, and only 3 respondents (7.3%) associated it with knowledge of psychological theories and concepts. The findings demonstrate that an understanding of research culture as a broad professional characteristic extending beyond academic and study-related tasks has been formed in fewer than half of the students in the sample. A substantial proportion of future educational psychologists do not perceive research activity as an integral component of everyday professional practice, which may subsequently place significant limitations on their capacity for evidence-based justification of professional decisions (Figure 1).

Figure 1

Students' understanding of the essence of research culture of a teacher-psychologist



Responses to the second question, which addressed students' assessment of the role of university professional training in the development of research culture, were distributed as follows. Only 1 student (2.4%) evaluated the academic process as fully conducive to the formation of research culture. The predominant share of respondents - 20 individuals (48.8%) - indicated that training contributes to this only partially, given that no purposeful system has been established. The view that the academic process makes a negligible contribution was held

by 16 students (39.0%), while 4 respondents (9.8%) indicated that it makes no contribution whatsoever. Taken together, 97.6% of future educational psychologists assess the contribution of university training to the development of research culture as insufficient. This points to the fact that the existing system of professional preparation does not ensure the systematic and consistent cultivation of students' research culture, and signals the need for the deliberate incorporation of appropriate pedagogical means into the educational process (Figure 2).

Figure 2

Students' assessment of the role of university professional training in the development of research culture

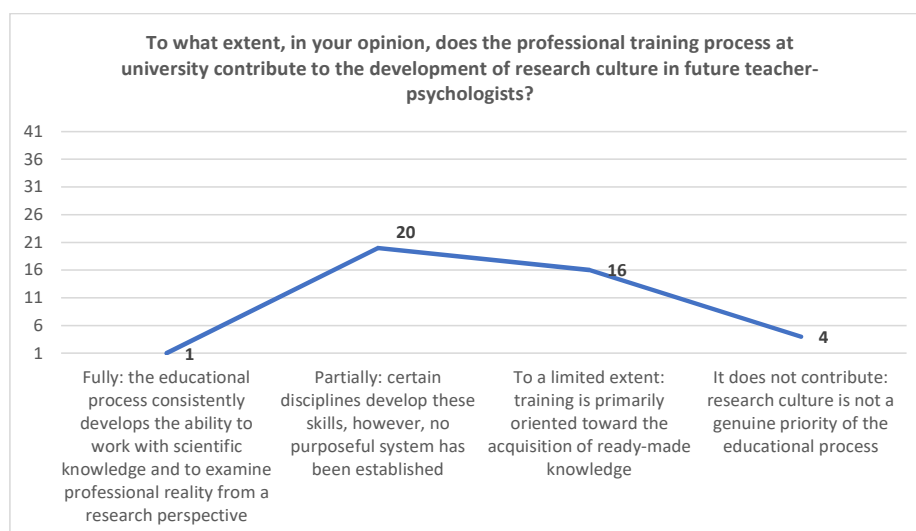
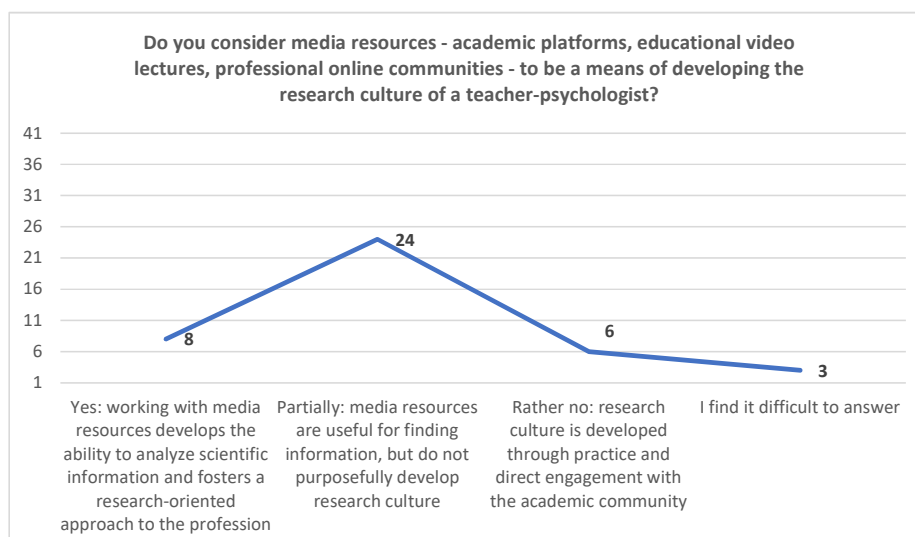


Figure 3

Students' attitudes toward media resources as a means of developing research culture of a teacher-psychologist

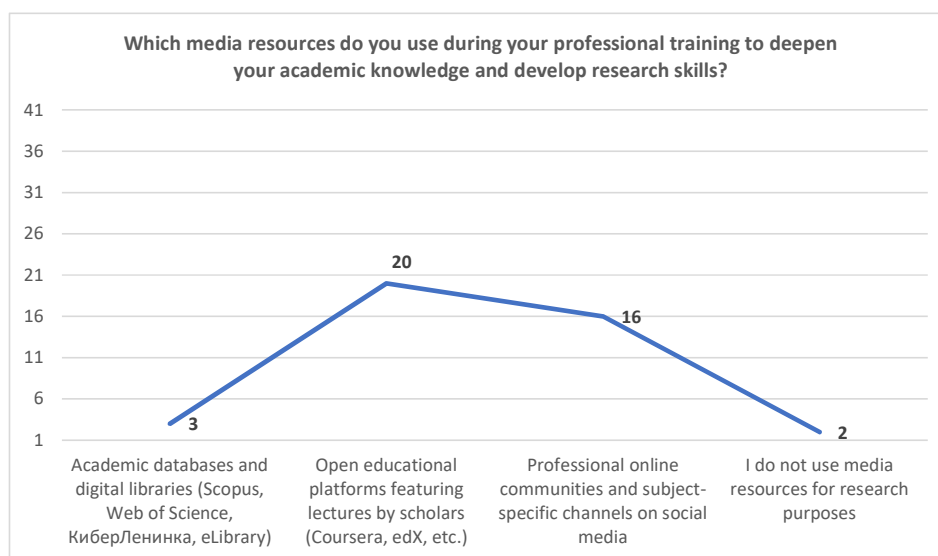


The results of the third question, which examined students' attitudes towards media resources as a means of developing research culture, showed that the largest share of respondents - 24 individuals (58.5%) - recognize media resources as a partially suitable tool, useful for information retrieval, but do not regard them as an instrument for the purposeful formation of research culture. An affirmative position was taken by 8 students (19.5%), who consider that working with media resources cultivates a research-oriented attitude towards the profession. A negative position was expressed by 6 respondents (14.6%), while 3 respondents (7.3%) were unable to provide an

answer. The predominance of partial recognition over full recognition indicates that students intuitively sense a connection between media resources and professional development, yet do not sufficiently understand the mechanism underlying this connection. Media resources are perceived primarily as a technical tool for information retrieval rather than as a pedagogically meaningful means of forming a research disposition and critical professional thinking - highlighting the need for dedicated work aimed at developing in future educational psychologists a conscious and purposeful approach to media resources within the context of their professional formation (Figure 3).

Figure 4

Students' use of media resources during professional training



Responses to the fourth question, concerning the actual use of media resources in the course of professional training, are broadly consistent with the findings of the preceding question. Scholarly databases and electronic libraries are used by only 3 students (7.3%), open educational platforms featuring lectures by researchers by 20 individuals (48.8%), and professional online communities and subject-specific social media channels by 16 respondents (39.0%). Meanwhile, 2 students (4.9%) indicated that they do not use media resources for research purposes at all. It is notable that the least utilized resources proved to be precisely those - scholarly databases and academic libraries

- that provide the greatest access to verified scientific knowledge and develop the ability to work with primary sources. The predominance of informal educational platforms and social media over academic databases reveals that students' engagement with media resources is spontaneous and situational in character and is not subordinated to the goals of purposeful research culture development. Without specially organized pedagogical support, media resources remain an unrealized asset in the professional formation of future educational psychologists (Figure 4).

Discussion. The results of the pilot survey reveal a picture broadly characteristic of the

professional training of future educators in contemporary conditions: an understanding of research culture as a wide-ranging professional characteristic is insufficiently formed among students, university training is not perceived by them as ensuring the systematic development of a research disposition, and media resources are used primarily in a spontaneous manner and are not associated by students with the goals of professional research formation. The findings are consistent with the conclusions of Matjašič and Vogrinc (2025), who examined the development of perceived and actual research competence among master's-level students in a pedagogical program at the University of Ljubljana ($n = 73$). The authors established that at the initial stage of study, students systematically overestimate their own research competence, failing to appreciate its genuine complexity and multidimensionality, and only as they become engaged in practical research activity does their self-assessment become more realistic (Matjašič & Vogrinc, 2025). A similar dynamic is observable in our sample: fourth-year students, who possess a substantial body of subject knowledge, nonetheless do not perceive research activity as an organic component of the educational psychologist's professional practice - a finding that points to a gap between accumulated knowledge and a formed research disposition.

This gap is largely explained by the absence of systematic pedagogical work aimed at developing research culture within the framework of professional training. Gussen et al. (2023), who studied the development of research competence among pre-service teachers at German universities, found that many students in pedagogical programs hold a critical attitude towards research activity and demonstrate an insufficient level of methodological knowledge - precisely as a consequence of the absence of specially organized research courses within their curricula (Gussen et al., 2023). The authors demonstrated that only purposeful pedagogical support, incorporating practical research assignments, is capable of producing a substantive shift in both the cognitive and the affective-motivational dimensions of students' research competence.

With regard to the role of media resources in the development of research culture, our data resonates with the observations of Laptun and Safonov (2022), who examined the pedagogical conditions for developing media culture in future teachers. The authors established that media culture as a professional quality does not form spontaneously through everyday use of media tools but requires specially designed methodological conditions and practical tasks that are purposefully integrated into the educational process (Laptun & Safonov, 2022). The predominance in our sample of students' orientation towards informal educational platforms and social media at the expense of academic databases corroborates the same logic: without pedagogically organized support, media resources remain for students an instrument of situational information retrieval rather than a means of developing a research disposition and critical professional thinking. The results of the present study and the findings of the international works examined thus point to one, and the same systemic pattern: the development of research culture in future educators - including through media resources - does not occur spontaneously in the course of standard professional training, and requires purposeful pedagogical design.

Conclusion. The relevance of the problem of developing research culture in future educational psychologists is determined by the objective demands of contemporary professional reality: the growing complexity of psychological needs within the educational environment, the dynamic renewal of scientific knowledge in the fields of psychology and pedagogy, and the pervasive spread of the media environment as a space for the specialist's professional formation. Under these conditions, the future educational psychologist's capacity to critically engage with scientific information, reflectively interpret professional practice, and justify decisions on the basis of verified knowledge ceases to be an optional quality and acquires the status of a professional norm.

The pilot survey conducted yielded preliminary empirical data on the level of readiness among fourth-year students of the Educational Psychologist program to develop

research culture through media resources. The results showed that an understanding of research culture as a broad professional characteristic has been formed in fewer than half of the respondents; university training in its current form is not perceived by students as ensuring the systematic development of a research disposition; and media resources are used primarily in a situational manner and are not associated by students with the goals of professional research formation. The findings demonstrate the existence of a persistent deficit both in awareness of the significance of research culture and in the practice of its development through the media environment.

It is nonetheless necessary to acknowledge the limitations of the study. The pilot nature of the survey and the relatively small sample size - 41 students from a single year and degree program, 6B01101 Pedagogy and Psychology - preclude the generalization of the findings to a broader population. The closed-ended format of the questionnaire items limits the depth of interpretation: behind the quantitative distributions of responses, the individual mea-

nings and motivational foundations of students' professional dispositions remain invisible. A cross-sectional design does not permit conclusions to be drawn regarding the dynamics of research culture development across the course of study.

The prospects for further research involve expanding the sample to include students from different years of study and different universities, which would make it possible to identify the dynamics of research culture formation at various stages of professional training. Enriching the methodology through the inclusion of qualitative methods - interviews and focus groups - would yield a more detailed understanding of the content of students' professional dispositions towards research activity and media resources. On the basis of the data obtained, it appears feasible to proceed to the design of pedagogical conditions under which media resources become a structuring element of future educational psychologists' professional training, ensuring the purposeful and sustainable development of research culture.

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Psychological and Pedagogical Significance of Factors Influencing Self-Esteem of Students

Abstract

Introduction. In contemporary education, self-esteem is widely recognized as an important psychological and pedagogical factor associated with students' academic functioning, learning motivation, and social adaptation. As a multifaceted component of self-consciousness, self-esteem functions as an internal regulatory mechanism shaping emotional stability, goal-setting processes, and self-regulated learning behaviors. From this perspective, self-assessment contributes to learners' ability to critically evaluate and manage their educational outcomes, thereby supporting the development of autonomous and reflective individuals within modern educational systems. **Methodology and Methods.** The study employed a quantitative, cross-sectional correlational design. The participants were 171 first- to fourth-year students aged 19–22 years who were enrolled in pedagogy and psychology programs at two universities in Kazakhstan. Self-esteem was assessed using the Rosenberg Self-Esteem Scale, while psychological well-being was measured using the shortened SPWB-18 scale. Social comparison and problematic digital use were examined through a separate set of questions. The data were analyzed using descriptive statistics and Pearson correlation analysis. **Results.** Most participants demonstrated medium (43.9%) or high (42.1%) levels of self-esteem, while 14.0% were classified as having a low level. Self-esteem was positively associated with psychological well-being ($r = .52$) and negatively associated with social comparison ($r = -.46$) and problematic digital use ($r = -.41$). Social comparison was also negatively associated with psychological well-being ($r = -.39$), whereas problematic digital use showed a negative association with psychological well-being ($r = -.44$). **Scientific novelty.** The study provides empirical evidence on the relationships between self-esteem, psychological well-being, social comparison, and problematic digital use among university students in Kazakhstan. By examining these variables within the same student sample, the findings contribute to a more integrated understanding of the psychological and digital factors associated with students' self-esteem. **Practical significance.** The findings may be useful in developing psychological and pedagogical support practices for university students, particularly those aimed at strengthening reflective skills, promoting responsible digital behavior, and supporting psychological well-being.

Keywords: self-esteem, self-assessment, self-regulated learning, motivation, pedagogical psychology, educational process, reflection.

Introduction. Self-esteem is an important aspect of students' psychological development in the educational environment. It reflects how individuals perceive their own value, abilities, and competence. University students regularly face academic demands, new social relationships, and changes related to their personal and professional development. These experiences

can influence how they see themselves and how they respond to difficulties during their studies. Students with a more positive sense of self tend to report better psychological well-being and emotional adjustment and may cope more effectively with academic and social challenges. For this reason, self-esteem can be considered not simply as a component of self-perception,

but as an important psychological resource related to students' adaptation to university life (Ismailova et al., 2025).

At the same time, self-esteem and self-assessment should not be treated as identical concepts. Self-esteem concerns a person's general sense of self-worth, whereas self-assessment in education refers mainly to students' evaluation of their own learning and academic performance. When students assess their own work, they have an opportunity to consider what they have achieved, recognize difficulties, and decide what needs to be improved. In this sense, self-assessment becomes part of the learning process rather than simply a way of judging results. Studies in higher education have shown that formative assessment and well-organized self-assessment can encourage reflection and support self-regulated learning (Parmigiani et al., 2024; van der Linden et al., 2023). Although self-esteem and self-assessment are different constructs, reflective assessment practices may therefore help students become more aware of both their learning processes and their own capabilities.

The role of self-esteem becomes especially noticeable during the university years, when students take on greater academic responsibility and gradually develop their personal and professional identities. How students perceive their own competence may also be related to their willingness to participate actively in learning and work toward academic goals. Ullah et al. (2024), for example, reported a significant relationship between academic motivation and self-esteem among university students, although this relationship differed across dimensions of motivation. This suggests that self-esteem should be considered together with motivational factors when examining how students adapt to and engage in higher education.

The President of the Republic of Kazakhstan, K.K. Tokayev, in his address of September 1, 2021, entitled "Unity of the People and Systemic Reforms - a Solid Foundation for the Future", noted: "The education system needs high-quality specialists. Increasing the effectiveness of teacher retraining and strengthening the requirements for pedagogical higher education

institutions are urgent issues" (Tokayev, 2021). In this regard, it is clearly seen that, in addition to the professional competence of a teacher, his personal qualities and level of self-esteem also affect the quality of education.

The issues of improving the quality of the educational process, the enhancement of the social status of teachers, and the improvement of methods of assessing the achievements of the training are the key directions of the state policy in Kazakhstan. At the plenary session of the August Conference named "Education of the Future: Honest Citizen, a Professional," in the presence of the educationists from all regions of Kazakhstan, the Head of State stated important priorities and directions that should be considered to improve the quality of education and increase the significance of the teachers' role and their social status. In particular, the issues concerning the role of teachers as the main driver of the education system, the vital importance of schools in society, the provision of high-quality education, and the development of the teaching profession and its social importance were mentioned. Also, the quality of education in the country and the development and upbringing of children should be highlighted (Tokayev, 2024).

The psychological and pedagogical analysis of self-esteem factors is relevant precisely in this reform context, since:

- self-esteem indirectly and directly determines learning motivation, academic achievement, and social adaptation;
- a teacher's professional reflection and professional self-esteem contribute to the quality of teaching through the teacher's stability, professional growth, and self-efficacy;
- in an environment with an established assessment culture, a student develops self-assessment skills and adapts to managing learning outcomes.

In Kazakhstan, educational quality is addressed not only through teaching standards but also through a system of monitoring and assessment. Article 55 of the Law "On Education" provides the legal basis for this process, stating that education quality management forms part of the national quality assessment system. The same

article also identifies educational monitoring as a means of collecting indicators used in both internal and external evaluation of educational quality (Qazaqstan Respublikasy, 2007).

In addition, Government Resolution No. 249 dated March 28, 2023, “On approval of the concept on the development of preschool, secondary, technical and vocational education in the Republic of Kazakhstan for 2023-2029,” provides information on the development strategy for the organization and control over the educational process (Qazaqstan Respublikasy Ukimeti, 2023).

The criteria used to evaluate educational organizations are further specified in Order No. 486 of the Minister of Enlightenment of the Republic of Kazakhstan, adopted on December 5, 2022. The document sets out the main requirements for evaluating educational organizations and also provides a regulatory framework for the self-assessment of their educational activities (Qazaqstan Respublikasy Oqu-agartu ministriligi, 2022). These documents indicate the increased requirements for a culture of evaluation and reflective practice in managing the quality of education, and one of the psychological foundations of this is the self-assessment of the individual.

These circumstances increase the relevance of studying the self-assessment of the individual. On the one hand, although there is high scientific interest in this issue, on the other hand, there is a lack of research that comprehensively and systematically considers the psychological and pedagogical factors that influence the formation of self-assessment. Given the current scenario where the digital landscape is growing larger and social comparison is increasing, coupled with changes in evaluation methods in education, it becomes necessary to revisit the matter from a modern point of view. The findings of numerous international studies have shown that there is always a connection between self-esteem and academic success. In fact, several meta-analyses have brought to light additional links between self-esteem and various other matters. (Gholizade et al., 2024).

Simultaneously, despite the obvious necessity and relevance of research into the role of self-

esteem in modern scientific literature, the issue has not been investigated from the point of view of identifying psychological and pedagogical factors promoting self-esteem development on a comprehensive level. There is a pressing need to find effective methods and pedagogical conditions conducive to self-esteem formation. This confirms the relevance of the research topic.

The present study examines how university students’ self-esteem is related to psychological well-being, social comparison, and problematic digital use. It also considers the psychological and pedagogical relevance of these relationships within the university educational environment.

Based on this purpose, the study addresses the following research question: How is university students’ self-esteem related to psychological well-being, social comparison, and problematic digital use?

It was hypothesized that higher self-esteem would be positively associated with psychological well-being and negatively associated with social comparison and problematic digital use.

The scientific significance of the study is determined by the careful consideration of self-esteem as an indicator of personal development, a key factor in learning motivation, and a component of a teacher’s professional reflection. The practical significance is characterized by the fact that it allows for developing recommendations aimed at improving the culture of assessment in educational organizations and developing students’ self-esteem and self-regulation skills.

Materials and Methods. The empirical part of the study was designed as a quantitative, cross-sectional correlational study. It focused on the relationships between university students’ self-esteem, psychological well-being, social comparison, and problematic digital use. Before the empirical analysis, relevant psychological and pedagogical studies were reviewed to provide a theoretical basis for the research and to identify the main factors that may be related to students’ self-esteem.

In modern psychological and pedagogical science, a person’s self-esteem is considered an important determinant of personal

development, psychological well-being, and academic and professional success. In domestic and foreign studies published in recent years, the interrelationship of social, pedagogical, and digital factors contributing to the formation of self-esteem has been comprehensively studied.

The interconnection between self-esteem and psychological well-being has already been empirically tested in other studies. According to A. Ismailova's work, psychological well-being is linked with self-esteem among students (Ismailova, 2025). Based on the author's claims, if there is a negative influence of high levels of social comparisons on the psychological condition of an individual, then self-esteem and communication skills can be considered key factors responsible for the improvement of a person's well-being. Thus, the given assumption proves the importance of self-esteem as a key psychological resource.

Similar results were obtained in Kazakhstani studies. N. Auyelbekova's scientific research considers self-esteem in relation to socio-psychological factors such as anxiety level, feeling of social support, and feeling of loneliness (Auyelbekova et al., 2025). It was shown that people with low self-esteem usually have poor mental health, and this demonstrates the preventive function of self-esteem.

In the contemporary educational environment, the influence of the digital context on personal development requires particular attention. A study carried out among high school students by B. Idrees and colleagues indicated that there is a correlation between technology addiction and life stressors as well as low self-esteem (Idrees et al., 2024). Such results imply that, in the absence of proper regulation, the technological space might pose a threat to self-esteem.

The impact of the digital environment on adolescent behavior and self-esteem is also addressed in pedagogical research by Kazakh scholars. A. Turysbayeva, A. Zhumabaeva, K. Yesenova, T. Bainazarova, and S. Maigeldieva demonstrate that students' self-assessment skills develop through the use of formative assessment methods, thereby emphasizing the importance of a pedagogically well-structured digital and evaluative environment (Turysbayeva et al.,

2023). In addition, researchers have found that the systematic use of formative assessment, feedback, and self-assessment methods increases students' self-reflection and learning responsibility (Turysbayeva et al., 2023). This study allows us to consider self-assessment as a pedagogical tool and demonstrates the importance of pedagogical support and a culture of assessment in the formation of self-esteem.

The analysis of the literature showed that self-esteem is a multifaceted psychological and pedagogical phenomenon. Its formation is influenced by social comparison, the digital environment, pedagogical support, and personal resources. Foreign, Russian, and Kazakhstani studies prove that self-esteem is an important indicator of psychological well-being and an object of targeted pedagogical influence that requires development in the educational process.

In this regard, a systematic analysis of the factors of a person's self-esteem forms the scientific basis for improving the culture of psychological support and assessment in educational organizations.

The logic of the study was based on careful consideration of students' self-esteem, with personal and social factors presented in modern psychological and pedagogical works (Ismailova, 2025; Idrees et al., 2024).

The study involved students of higher education institutions studying in the educational program of pedagogy and psychology. The empirical study was conducted at Zh.A. Tashenev University and Academician A. Kuatbekov Peoples' Friendship University. The study sample included students of the 1st–4th year of the mentioned universities ($N = 171$). The age of the participants ranged from 19 to 22 years.

The selection was voluntary, and informed consent was obtained from all participants during the study.

Methods and techniques used

1. Determining the level of self-esteem of students. The Rosenberg Self-Esteem Scale (RSES) was used to measure self-esteem. This method has been widely used in working with students and has been revalidated in recent years.

Scale characteristics:

- consists of 10 statements;
- 4-point Likert scale;
- determines the level of overall self-esteem.

The psychometric basis of the method has been confirmed in recent studies:

The scale has shown high internal reliability and factor structure in a cohort of students and young people (Moksnes et al., 2024; Ghasempour et al., 2025).

2. Measuring psychological well-being

A shortened SPWB-18 scale based on the Ryff model was used to assess the psychological well-being of students. This version is convenient to use with a large number of students and has been validated in several countries in recent years.

The dimensions assessed are:

- self-perception;
- meaning of life;
- autonomy;
- quality of social relationships;
- personal development.

The validity and reliability of the SPWB-18 scale have been proven in recent studies (Garcia et al., 2023; Tibubos et al., 2025).

3. Social comparison and digital environment factors

A block of questions based on problematic technology use and social comparison indicators was used to assess the behavior of students in the digital environment and the level of social comparison.

This block was developed based on the methodological approaches used in the study by B. Idris and colleagues and included the following aspects:

- frequency of comparing oneself with others on social networks;
- screen time;

- emotional reactions in the digital environment.

Ethical consideration. Participation in the study was voluntary, and informed consent was obtained from all participants before data collection. The students were informed about the purpose of the research and were free to withdraw from the study at any stage without any consequences. No personally identifying information was included in the analysis, and the collected data was used only for research purposes. As the study was based on non-invasive questionnaire procedures, participation did not involve any experimental intervention. Formal institutional ethical approval had not been obtained before the data was collected. For this reason, particular care was taken to ensure voluntary participation, informed consent, anonymity, confidentiality, and the protection of participants' personal information throughout the research process.

Data processing methods. The data obtained was processed using the following statistical methods:

- descriptive statistics (means, percentages);
- grouping by level of self-esteem (low, medium, high);
- correlation analysis (Pearson r) - to identify the relationships between self-esteem and psychological well-being, social comparison, and digital factors.

This approach allows for a comprehensive analysis of the factors affecting students' self-esteem.

Results. The results of the study allowed us to identify the relationships between the level of self-esteem of students, psychological well-being, and digital environment factors (Table 1).

Table 1

Distribution of Students by Self-Esteem Level (N = 171)

Self-esteem level	n	(%)
High	72	42.1
Moderate	75	43.9
Low	24	14.0
Total	100	100.0

During the description of the research results, the percentage distribution of the self-esteem levels of the students was determined. According to the data received, moderate (43.9%) and high (42.1%) levels of self-esteem were observed in the majority of

participants, and a low level was observed in 14.0% of students. These indicators show that self-esteem is sufficiently developed in most students. The percentage distribution of students across the three self-esteem levels is presented in Figure 1.

Figure 1

Percentage Distribution of Students by Self-Esteem Level

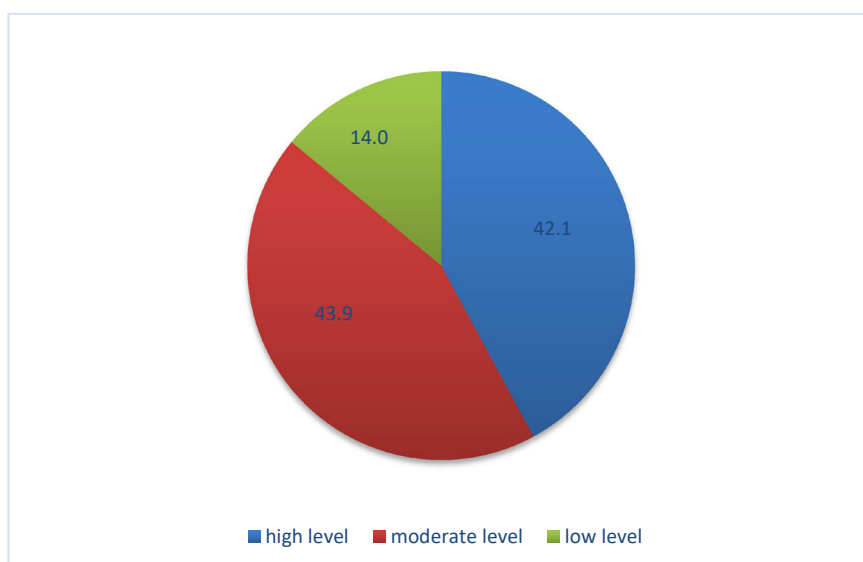


Figure 1 shows the percentage distribution of students' self-esteem levels. According to the results, it can be seen that the average and high levels of self-esteem prevail. In addition,

in the course of the study, a correlation analysis was conducted in order to determine the interrelationships between the variables (Table 2).

Table 2

Correlations Between Self-Esteem, Psychological Well-Being, Social Comparison, and Digital Factors
- italic

Variables	r^2	(%)
Self-esteem – Psychological well-being	.52	27
Self-esteem – Social comparison	-.46	21
Self-esteem – Problematic digital use	-.41	17
Social comparison – Psychological well-being	-.39	15
Digital use – Psychological well-being	-.44	19
Social comparison – Digital use	.49	24

The correlation analysis showed clear relationships among the variables examined in the study. Self-esteem was positively related to psychological well-being ($r = .52$), with the two variables sharing approximately 27% of their variance. In other words, students who reported higher self-esteem generally also reported higher psychological well-being.

A different pattern was observed for social comparison and problematic digital use. Self-esteem was negatively related to social comparison ($r = -.46$), accounting for approximately 21% shared variance. The relationship between self-esteem and problematic digital use was also negative ($r = -.41$), with about 17% shared variance. Students

who reported more frequent social comparison or greater problematic digital use therefore tended to have lower self-esteem.

The remaining correlations followed a similar pattern. Social comparison was negatively related to psychological well-being ($r = -.39$), as was problematic digital use ($r = -.44$). At the same time, social comparison and problematic digital use were positively related ($r = .49$). Taken together, these results show that self-esteem and psychological well-being were positively connected in this sample, whereas both tended to be lower among students reporting greater social comparison and problematic digital use.

Discussion. The results of this study show that self-esteem is related to several aspects of students' psychological and social experience. Students with higher self-esteem generally reported better psychological well-being, while those who engaged more frequently in social comparison or reported greater problematic digital use tended to have lower self-esteem. This pattern suggests that self-esteem cannot be considered separately from the wider context in which students study, communicate, and evaluate themselves. Similar relationships between self-evaluation, psychological well-being, and students' social experiences have also been reported in recent research (Ismailova et al., 2025).

One of the clearest relationships found in the study was between self-esteem and psychological well-being ($r = .52$). Students who viewed themselves more positively also tended to report better psychological well-being. Ismailova et al. (2025) reported a comparable pattern among university students, identifying self-esteem as a significant positive predictor of psychological well-being. Cui et al. (2024) reached a similar conclusion in their cross-sectional study of 689 Chinese university students, where self-esteem and mental well-being were positively correlated ($r = .60$). The association in their study was somewhat stronger than the one found here ($r = .52$), but the overall pattern is similar: in both samples, more positive self-evaluation was linked with better psychological well-being.

Evidence from longitudinal research provides another perspective on this relationship. Gao et

al. (2022) followed Chinese college students over four academic years and found that higher self-esteem was associated with lower levels of depression, with the relationship also observed over time. Depression is not the same construct as the psychological well-being examined in the present study, so the findings cannot be compared directly. Even so, the longitudinal results are relevant because they show that self-esteem remains connected with students' psychological adjustment across different stages of university study.

Differences in the strength of these relationships across studies may be related to the populations studied, cultural settings, or the measures used to assess self-esteem and psychological well-being. Despite these differences, the pattern found among the Kazakhstani students in the present study is broadly consistent with findings from other university populations. This similarity should still be interpreted with caution. The present study was cross-sectional and correlational; therefore, the positive relationship observed between self-esteem and psychological well-being cannot establish that higher self-esteem leads to better psychological well-being (Cui et al., 2024; Ismailova et al., 2025).

Rosenthal and Tobin (2023) offer a related example from a sample of 437 U.S. college students. They found that higher self-esteem was associated with fewer depressive symptoms, while longer daily social media screen time was linked to greater odds of reporting depressive symptoms. Although their study focused on depressive symptoms rather than psychological well-being, it points to the relevance of both self-esteem and digital behavior when considering students' psychological adjustment.

Rehman et al. (2023) reported a comparable relationship among university students. In their study, self-esteem was positively related to psychological well-being and also served as a mediator between mindfulness and psychological well-being. Their analysis involved a different set of variables from those examined here, but the general pattern is similar: students' perceptions of themselves appear to be closely connected with their psychological well-being.

Social comparison showed a different relationship with self-esteem in the present study. The correlation was negative ($r = -.46$), meaning that students who compared themselves with others more often generally reported lower self-esteem. This pattern has also been observed in studies of social comparison in digital settings (Ismailova et al., 2025). For example, Zuo and Zan (2025) studied 500 Chinese college students and found that cyber upward social comparison was negatively related to self-esteem. They also found that self-esteem mediated the relationship between cyber upward social comparison and well-being.

Servidio et al. (2024) reported similar results in a sample of 256 Italian university students. Social comparison was negatively correlated with self-esteem ($r = -.26, p < .001$), although this relationship was weaker than the one found in the present sample ($r = -.46$). The direction of the association, however, was the same in both studies. Servidio et al. also found a positive relationship between social comparison and problematic social media use ($r = .30$) and a negative relationship between self-esteem and problematic social media use ($r = -.21$). This combination of findings is useful for interpreting the present results, as it suggests that social comparison, self-esteem, and problematic digital behavior are connected aspects of students' experience rather than entirely separate processes.

The way social comparison occurs may also matter. R  ther et al. (2023) examined this issue experimentally in a sample of 231 female university students. Exposure to positively biased images posted by social media influencers encouraged upward comparison, which was subsequently linked to lower state self-esteem. This result helps to interpret the present findings from a broader perspective. The relationship between social comparison and self-esteem may depend not only on how often students compare themselves with others, but also on whom they compare themselves with and the type of digital content they encounter.

Taylor and Armes (2024) approached the issue by examining the direction of comparison on Instagram. They found that self-esteem and

body-esteem increased following exposure to downward-comparison images. Upward comparison, in contrast, was followed by a significant decrease in body-esteem, but not in self-esteem. This distinction is relevant to the negative correlation found in the present study ($r = -.46$). It suggests that different forms of comparison may not have the same relationship with self-evaluation and that the outcome may also depend on whether general self-esteem or a more specific aspect, such as body-esteem, is being considered.

The differences in the strength of associations reported across studies may be related to the characteristics of the samples, the sociocultural settings in which the research was conducted, and the measures used to assess social comparison and digital behavior. There are also differences in how social comparison itself has been defined. Zuo and Zan (2025), for instance, focused specifically on upward comparison in online environments, while the present study examined a broader tendency to compare oneself with others. Future studies could distinguish more clearly between upward and downward comparison and explore whether these forms are related to self-esteem in different ways across online and offline settings (Servidio et al., 2024; Zuo & Zan, 2025).

Problematic digital use was also related to self-esteem in the present sample. The association was moderately negative ($r = -.41$), with students reporting greater problematic digital use generally showing lower self-esteem. Idrees et al. (2024) observed a similar relationship among high school students, where problematic technology use was associated with lower self-esteem. Yang et al. (2024) reported the same direction of association in a cross-sectional sample of 806 undergraduate students, although the correlation between self-esteem and problematic mobile phone use was weaker ($r = -.24, p < .001$) than the one found here ($r = -.41$). The difference may be related to the way problematic digital use was measured, as well as to differences in the samples and sociocultural settings. Yang et al. (2024) also found that fear of missing out partly mediated the relationship between self-esteem and problematic mobile

phone use. This may offer one explanation for how students' self-evaluation and problematic patterns of digital use become connected.

A broader picture emerges from the systematic review by Sánchez-Fernández and Borda-Mas (2023), which covered 117 studies of university students. Their review linked problematic smartphone and Internet use with a range of psychological factors, while also drawing attention to substantial differences in how problematic digital behavior has been defined and measured across studies. Such variation may help explain why the strength of reported associations is not always consistent. The present findings should nevertheless be interpreted within the limits of the research design. Since the data were collected at one point in time and analyzed correlationally, they do not establish whether problematic digital use contributes to lower self-esteem, whether lower self-esteem is related to greater problematic digital use, or whether other factors are involved (Idrees et al., 2024; Yang et al., 2024).

Chen et al. (2023) provide another useful comparison. In their study of 694 college students, self-esteem was negatively related to mobile phone addiction, while social avoidance and peer relationships were identified as possible mediating mechanisms. Their results suggest that the connection between self-esteem and problematic digital behavior may involve students' interpersonal experiences as well as individual psychological characteristics.

Meta-analytic evidence points in the same direction. Ding et al. (2022) combined the results of 56 studies involving 42,300 participants and reported a moderate negative relationship between smartphone addiction and self-esteem ($r = -.25$). This association was weaker than the one observed in the present study ($r = -.41$), but both results show the same general pattern: greater problematic smartphone or digital use tends to be associated with lower self-esteem.

The findings also have relevance for educational practice, although global self-esteem should not be confused with students' self-assessment of their learning. In Kazakhstan, Turysbayeva et al. (2023) showed that the systematic use of formative assessment

techniques can help primary school students develop their self-assessment skills. Their study involved younger learners and focused on academic self-assessment rather than global self-esteem, so a direct comparison with the present results would not be appropriate. Nevertheless, it illustrates how educational practices can create opportunities for students to reflect on their progress and evaluate their own learning. In the present university sample, global self-esteem was related not only to psychological well-being but also to students' social comparison and problematic digital use. These results point to the value of combining reflective learning practices with broader psychological and pedagogical support for students (Turysbayeva et al., 2023).

Taken as a whole, the results show that self-esteem is connected with several aspects of students' experience in higher education. Higher self-esteem was associated with better psychological well-being, while greater social comparison and problematic digital use were associated with lower self-esteem. Looking at these relationships together may provide a more complete picture of how students evaluate themselves within their academic, social, and digital environments. For educational practice, this draws attention to the value of reflective learning, responsible digital behavior, and accessible psychological and pedagogical support. These implications should, however, be considered with caution. Because the study was cross-sectional and correlational, the relationships identified here do not show that one variable causes changes in another. Rather, they identify patterns that can be examined more closely in future longitudinal and intervention-based research.

Several limitations need to be taken into account when interpreting the results of this study. The first concerns the cross-sectional design. Since the data were collected at a single point in time, the study cannot establish the direction of the relationships between self-esteem, psychological well-being, social comparison, and problematic digital use. This is especially relevant because self-esteem may not remain unchanged throughout university

years. Liu et al. (2024), using four waves of longitudinal data from Chinese college students, identified different patterns of self-esteem development over time and found that these trajectories were associated with different psychological outcomes. The present study offers only a snapshot of these relationships and cannot show how they may change as students progress through university.

A second limitation concerns the sample. The participants were 171 pedagogy and psychology students from two higher education institutions in Kazakhstan. The findings therefore should not be generalized to all university students without further evidence. Students from other academic disciplines, institutions, age groups, or sociocultural settings may show different patterns of relationships. A third limitation is the reliance on self-report measures. Students' responses reflect their own perceptions and may be influenced by individual response tendencies.

Future studies could address these limitations by following students over longer periods or by using experimental and intervention-based designs where appropriate. Larger and more diverse samples from different universities and fields of study would also make it possible to examine whether the relationships found here are observed in other student populations. Combining questionnaires with qualitative interviews, behavioral indicators, or other sources of data may provide a fuller understanding of students' experiences. It would also be useful to distinguish between different forms of social comparison and patterns of digital use rather than treating them as broad categories. Such research could clarify how these factors are related to changes in self-esteem and psychological well-being during university education (Liu et al., 2024).

Conclusion. The present study explored how self-esteem is related to psychological well-being, social comparison, and problematic digital use among university students. Self-esteem showed a positive relationship with psychological well-being ($r = .52$), while its relationships with social comparison ($r = -.46$) and problematic digital use ($r = -.41$) were negative. In practical terms, students with

higher self-esteem generally reported better psychological well-being, whereas those who engaged more frequently in social comparison or reported greater problematic digital use tended to have lower self-esteem.

These results place self-esteem within a wider psychological and educational context. Students' perceptions of themselves appear to be connected not only with their psychological well-being but also with the social and digital environments in which they interact. At the same time, these relationships should be interpreted carefully. Since the study was cross-sectional and correlational, it cannot determine whether social comparison or problematic digital use leads to lower self-esteem, or whether students with lower self-esteem are more likely to engage in these behaviors.

The distinction between global self-esteem and academic self-assessment is also important when considering the educational implications of the findings. Formative assessment, constructive feedback, and reflective activities can provide students with opportunities to evaluate their learning and develop greater awareness of their progress. Their direct influence on global self-esteem, however, was not examined in this study. These practices should therefore be viewed as possible elements of broader educational support rather than as interventions whose effects on self-esteem have already been established.

Further research could follow students over time to examine how self-esteem, psychological well-being, social comparison, and digital use change during university education. Studies involving students from different universities and academic disciplines would also help determine whether the relationships observed here are found in other populations. Particular attention could be given to different forms of social comparison and specific patterns of digital use. Longitudinal and intervention-based research may eventually provide a stronger basis for developing educational practices that support students' psychological well-being and adjustment to contemporary university life.

Conflict of Interest: The authors declare that they have no conflicts of interest related to this study.

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Socio-Cognitive Factors of Future Teachers' Personal Growth in the Cross-Cultural Context of Kazakhstan and China

Abstract

Introduction. The study examines socio-cognitive factors associated with the personal growth of pre-service teachers in the cross-cultural educational contexts of Kazakhstan and China. The research focuses on metacognitive regulation, emotional intelligence, empathy, and intercultural awareness as dimensions relevant to personal and professional development. **Methodology and methods.** A comparative mixed-methods design was used with 210 pre-service teachers, including 105 participants from Kazakhstan and 105 from China. Quantitative data were collected through a five-point Likert-scale questionnaire and analyzed using descriptive statistics, independent-samples t-tests, Pearson's correlation, and multiple regression. Qualitative data were obtained through semi-structured interviews with 20 participants and reflective journals and were examined using thematic analysis. **Results.** Kazakhstani participants demonstrated higher mean scores in metacognitive regulation, whereas Chinese participants demonstrated higher empathy scores. The regression analysis indicated that the examined socio-cognitive variables explained 46% of the variance in personal growth indicators in the Kazakhstani group and 44% in the Chinese group. Intercultural learning experiences were associated with adaptability, self-awareness, and professional identity development in both groups. **Scientific novelty.** The study develops an integrative conceptual model linking socio-cognitive factors with reflection, empathy, intercultural interaction, and personal growth in cross-cultural teacher education. **Practical significance.** The findings provide a basis for incorporating reflective learning, intercultural activities, and socio-emotional components into teacher education programs and international collaboration.

Keywords: socio-cognitive development, pre-service teachers, personal growth, intercultural education, empathy.

Introduction. Now with all this global change in education, training future teachers isn't stuck in one place anymore. Higher education is getting more international, so new ways of developing teachers focus on adapting socio-cognitively, handling cultures, and reflecting. The movement of students and teachers between Kazakhstan and China shows how cross-cultural settings change personal and thinking sides of teacher education. It builds flexibility in thinking and awareness socially.

The socio-cognitive approach helps explain this. Vygotsky said cognitive processes come from social interactions and culture, not just

alone (Vygotsky, 1978, as cited in Jusri et al., 2024). So for pre-service teachers, their development depends on the cultural learning environment. In places linking Kazakhstan and China, talking socially, learning together, and reflecting on culture drive intellectual growth. Seeing different teaching ways and cultures pushes flexibility, self-awareness, and empathy, which teachers need today.

Bandura's theory adds that cognition, behavior, and environment interact (Bandura, 1986, as cited in Kipchakova, 2023). Future teachers build identity not just from books but from engaging with social and cultural things.

Observing and internalizing cross-cultural experiences is key for growth. In Kazakhstan-China, philosophies differ: China has collectivist Confucian influences, Kazakhstan pushes autonomy, languages, innovation. This contrast is great for seeing socio-cognitive mechanisms across cultures; comparative data on human capital in the two countries are provided by Sarkytkan (2024).

Personal growth goes further than grades. Day and Gu (2010) associate resilience and moral purpose with teachers' personal and emotional health (see also Kuznetsov et al., 2021). Cross-cultural stuff helps rethink values, attitudes, responsibilities. For pre-service teachers, international settings build reflection, adaptability, emotional control, needed for diverse classes. So studying these factors in Kazakhstan-China context makes sense now. It shows how interaction, diversity, cognitive engagement form teachers holistically. Results could help policies for global, reflective educators in multicultural schools.

The personal growth of future teachers is increasingly understood as a multidimensional process that encompasses self-awareness, self-determination, reflective capacity, cognitive development, and professional identity formation. In this context, professional self-development represents an important mechanism through which future teachers develop the ability to evaluate their own competencies, establish professional goals, and regulate their learning trajectories. Imasheva and Toleubekova (2021) emphasize the importance of self-identification, self-esteem, self-determination, and self-government in the professional self-development of future social pedagogues, demonstrating that personal and professional development are closely interconnected. From a socio-cognitive perspective, the ways in which students perceive and process information may further influence their developmental potential. Prosekov et al. (2022) demonstrate a relationship between students' dominant cognitive styles and their creative abilities, suggesting that individual cognitive characteristics should be considered when examining students' educational and personal

development. These individual characteristics, however, develop within particular educational environments. Vashetina et al. (2022) highlight that the professional development of teachers and future teachers is influenced by multiple contextual factors and challenges, emphasizing the importance of supportive educational conditions and opportunities for continuous development.

This perspective is consistent with the systematic review conducted by Salmerón Aroca et al. (2023), which identifies continuous professional learning and the development of new competencies as important components of teachers' professional development. At the same time, contemporary higher education increasingly emphasizes student-centered approaches that encourage learners to actively identify challenges and participate in developing solutions. Ramos et al. (2024) show that a human-centered design thinking approach can support student success by placing students' needs and experiences at the center of educational improvement. Evidence that these competencies are amenable to targeted intervention is provided by Özdemir Cihan and Dilekmen (2024), who demonstrated in a mixed-methods quasi-experimental study that a training programme focused on social and emotional learning significantly increased the emotional intelligence of pre-service primary school teachers. Such approaches become particularly relevant in international and intercultural educational contexts, where students encounter new social, cultural, and academic experiences. In this regard, Zimmermann et al. (2024) found that international student mobility was associated with positive development in proactive personality, indicating that exposure to new environments and behavioural exploration may contribute to students' personal development. Taken together, these studies suggest that the personal growth of future teachers cannot be considered solely as an individual psychological process; rather, it emerges through the interaction of cognitive characteristics, reflective and self-regulatory capacities, professional development opportunities, student-centered educational practices, and intercultural experiences. This

provides a theoretical basis for examining socio-cognitive factors of future teachers' personal growth in cross-cultural educational contexts such as Kazakhstan and China.

The study aims to examine the socio-cognitive factors associated with the personal growth of pre-service teachers and to compare these factors among future teachers in Kazakhstan and China, with particular attention to metacognitive regulation, emotional intelligence, empathy, and intercultural awareness within cross-cultural educational contexts.

Materials and Methods. The study involved 210 pre-service teachers, including 105 participants from Kazakhstan and 105 participants from China. The participants were enrolled in international teacher education programs and represented different academic specializations, including English, pedagogy, and psychology. The participants were students in their third and fourth years of study. All participants had experience in an international or intercultural educational environment, including bilingual classes or student exchange activities, which was considered relevant to the objectives of the study. **Sampling Criteria.** A purposive sampling approach was used to recruit participants relevant to the research objectives. The sample was structured to provide comparable groups from Kazakhstan and China, with 105 participants from each country. Participants were selected from international teacher education programs and included students from different academic specializations and study years. Their previous exposure to bilingual, international, or intercultural educational activities was considered an important characteristic for participation in the study.

Data Collection Methods. A mixed-methods approach was used to collect quantitative and qualitative data. Quantitative data were collected using questionnaires based on the selected socio-cognitive and personal growth dimensions. The questionnaires were administered using a five-point Likert scale. Qualitative data were collected through semi-structured interviews and reflective journals. The interviews involved 20 participants, including 10 participants

from Kazakhstan and 10 from China. The interview questions focused on intercultural learning experiences, adaptation challenges, and participants' perceptions of changes in their personal and cognitive development. In addition, reflective journals completed during practicum were analyzed to identify recurring socio-cognitive themes.

Research Instruments. Three principal instruments were used in the study. The first was the Socio-Cognitive Development Questionnaire (SCDQ), adapted from the social cognitive framework and used to assess metacognitive regulation, intercultural awareness, and cognitive flexibility. The second was the Personal Growth Inventory (PGI), which assessed dimensions of personal development, including self-awareness, emotional intelligence, and reflective capacity. The third instrument was a semi-structured interview protocol, developed to explore participants' experiences of intercultural learning, adaptation, and personal and cognitive development. Reflective journals were additionally used as a qualitative data source.

Data Analysis Methods. *Quantitative data were processed using SPSS 27.0. Descriptive statistics, including means and standard deviations, were calculated for the main study variables. Independent-samples t-tests were used to compare the socio-cognitive indicators of participants from Kazakhstan and China. Metacognitive regulation was operationalized in line with Sapancı (2023), who examined metacognition in university students. Pearson's correlation coefficient was applied to examine the relationships between socio-cognitive factors and indicators of personal growth. Multiple regression analysis was conducted to determine the contribution of the selected socio-cognitive predictors to personal growth indicators.*

Qualitative data obtained from the semi-structured interviews and reflective journals were analyzed using thematic analysis based on Braun and Clarke's (2006) six-phase approach. The analysis included familiarization with the data, initial coding, development of themes, review of themes, definition and naming of themes,

and reporting. The quantitative and qualitative data were integrated at the interpretation stage. This integration made it possible to compare statistical patterns with participants' reported experiences and to provide a more comprehensive interpretation of the findings.

Reliability and Validity. The internal consistency of the quantitative instruments was assessed using Cronbach's alpha. The reported coefficients ranged from 0.81 to 0.89, indicating high internal consistency. Before the main data collection, the research instruments were piloted with 20 pre-service teachers from Kazakhstan and China. The use of questionnaires, semi-structured interviews, and reflective journals provided data triangulation and strengthened the consistency and contextual validity of the findings.

Ethical Considerations. The study adhered to international ethical research standards.

Participation was voluntary, and informed consent was obtained from all respondents. The anonymity and confidentiality of participants were maintained throughout the research process. Institutional approval was obtained from the ethics committees of the participating universities before the beginning of data collection.

Results. The data from mixed methods showed socio-cognitive factors really affect development of future teachers in both countries. Ill mix quant and qual to show similarities and differences. To assess the socio-cognitive factors and personal growth of pre-service teachers, a total of 210 respondents: Kazakhstan – 105; China – 105, were surveyed using a five-point Likert scale questionnaire. Table 1 presents the mean values and standard deviations for the main dimensions: metacognitive regulation, emotional intelligence, empathy, and intercultural awareness.

Table 1

Descriptive statistics of socio-cognitive factors among Kazakhstani and Chinese pre-service teachers

Indicators	Kazakhstan (M ± SD)	China (M ± SD)	Mean Difference	t-value	p-value
Metacognitive Regulation	4.08 ± 0.52	3.76 ± 0.47	0.32	3.87	0.000 **
Emotional Intelligence	3.92 ± 0.50	3.88 ± 0.44	0.04	0.65	0.52
Empathy	3.84 ± 0.48	4.19 ± 0.41	-0.35	-4.27	0.000 **
Intercultural Awareness	3.95 ± 0.53	3.89 ± 0.49	0.06	0.78	0.43

Note: $p < 0.01$ indicates statistical significance

Looking at the data, it seems Kazakhstani people did better on metacognitive regulation stuff. They showed more self reflection and that independent learning vibe. Chinese folks had higher empathy scores. This fits with their collectivist ideas, you know, focusing on how people connect and keep things harmonious socially. A multiple regression analysis was

conducted to determine which socio-cognitive predictors significantly influence personal growth indicators: self-reflective awareness, adaptability, and professional identity. So that part gets a bit tricky, since not everything lines up perfectly. Maybe the empathy ties into adaptability somehow (Table 2).

Table 2

Regression model of socio-cognitive predictors of personal growth

Predictor Variable	Kazakhstan (β)	China (β)	Significance (p)
Metacognitive Regulation	0.41	0.28	0.000 **
Emotional Intelligence	0.33	0.37	0.000 **

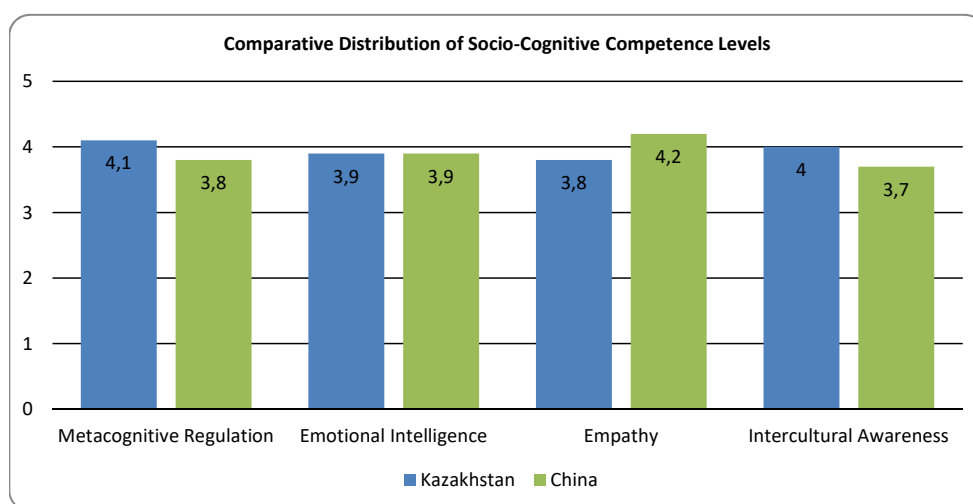
Empathy	0.25	0.43	0.001 **
Intercultural Awareness	0.29	0.31	0.004 **
R ² (Explained Variance)	0.46	0.44	—

These findings indicate that socio-cognitive variables collectively explain 46% of the variance in personal growth among Kazakhstani respondents and 44% among Chinese respondents. The most influential factors were metacognitive regulation for Kazakhstan and empathy for

China, confirming cross-cultural variations in personal development dynamics. To visualize the distribution of socio-cognitive competence levels, a comparative bar chart was generated see Fig. 1.

Figure 1

Comparative distribution of socio-cognitive competence levels among Kazakhstani and Chinese pre-service teachers



Bar chart showing mean values for four indicators: Metacognitive Regulation, Emotional Intelligence, Empathy, Intercultural Awareness - Kazakhstan vs. China.

The diagram clearly illustrates that Kazakhstani students outperform slightly in self-regulation and intercultural awareness, while Chinese respondents lead in empathy and emotional understanding. These tendencies reflect broader educational paradigms: Kazakhstani teacher education prioritizes reflective and critical thinking within modernization frameworks, whereas Chinese universities emphasize emotional literacy and relational ethics derived from Confucian traditions. The qualitative phase complemented the quantitative findings by explaining why these differences occurred. From the interviews I looked at, there were 20 people total, 10 from Kazakhstan and 10 from China, and some patterns kept coming up. In Kazakhstan, it was

this thing about reflective autonomy. Students there said that being in these multilingual and multicultural classrooms really helped them get better at planning their own learning, keeping track of it, and checking how they were doing. That makes sense with the higher scores they got on metacognitive regulation in the numbers part.

Over in China, the big one was collective empathy. The participants talked a lot about how teamwork and feeling for others was super important to who they were as professionals. They saw group learning as a way to build morals or something like that. And yeah, the stats showed empathy was the main predictor for the Chinese group. Both sides had stuff on intercultural awareness. People from each country mentioned how those joint seminars

and exchange programs built up tolerance and adaptability, plus this intercultural competence. It lined up with personal growth in the data, with a correlation of 0.61 and p less than 0.01. I think that's the part that stands out, how it

connects across. When you put the two datasets together, it points to this overall model for socio-cognitive development that's kind of universal, but still keeps the cultural differences clear. Like in Figure 2.

Figure 2

Conceptual model of socio-cognitive mechanisms of teacher growth in cross-cultural context

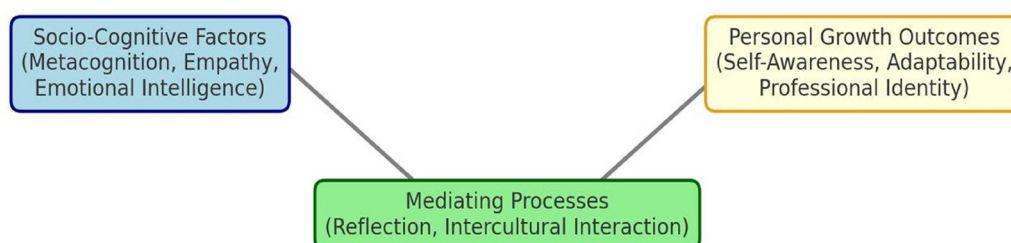


Diagram showing: Socio-Cognitive Factors → Mediating Processes (Reflection, Empathy, Intercultural Interaction) → Personal Growth Outcomes

The research here shows how things like metacognition, empathy, and emotional intelligence work in different contexts, mostly through reflection and how people interact with their culture, which helps with personal growth in the end.

Discussion. Thus, we think Kazakhstan's changes in education and China's focus on moral and group values kind of meet up in wanting teachers who are well-rounded, aware of social stuff, and able to regulate themselves for the future. The results from this study give pretty solid proof that these socio-cognitive things really shape how future teachers grow, both personally and in their jobs, especially in places where education is getting more international. By mixing numbers and stories from interviews, it points out patterns that are the same everywhere and ones that are more specific to each culture, like among pre-service teachers in Kazakhstan and China. That part stands out because it is not just one way of looking at it.

In the quantitative part, Kazakhstani people scored higher on metacognitive regulation, sort of keeping track of their own thinking, while the Chinese ones were better at empathy and focusing on relationships with others. This makes sense with how their education systems and traditions differ so much. Kazakhstan is pushing reforms to modernize and match global

standards, so they stress self-reflection, learning on your own, and thinking critically. On the other side, China's teaching is still tied to Confucian ideas that put collectivism first, with moral responsibilities, harmony in society, and being sensitive to emotions as key for professionals.

A comparable pattern is reported by Graziano et al. (2024), who found that the association between teacher empathy and perceived professional competence was moderated by emotional self-efficacy, indicating that empathy contributes to professional functioning only when it is accompanied by the capacity to regulate emotions. It ties into Bandura's social cognitive theory, where growth comes from balancing self-control, what is around you, and feedback on emotions and social stuff. The Chinese way of emphasizing empathy and moral sense feels like a unique cultural take on adapting socio-cognitively, and for Kazakhstan, it is more about reflection and directing yourself, which seems to build that inner cognitive independence. Some people might see these differences as bigger than they are, but overall, it shows how personal development adapts through these mechanisms.

The role of internationalized learning environments. The study confirms that exposure to international or intercultural learning environments acts as a catalyst for socio-

cognitive development. Both Kazakhstani and Chinese participants reported that participating in joint educational projects, bilingual programs, and student exchanges enhanced their intercultural awareness, communication competence, and adaptive learning strategies.

These experiences align with findings from recent comparative research on global teacher education, which argue that intercultural exposure enhances cognitive flexibility, empathy, and self-reflective growth. Students in both contexts described the international classroom not only as a site of knowledge exchange but as a transformative social space where they learn to reinterpret their identities and teaching roles. The regression stuff showed that those socio-cognitive things together explained around 45 percent of how personal growth happened in both the Kazakhstan and China groups. It kind of backs up the idea that metacognition, emotional intelligence, and empathy all connect to help with personal and professional stuff. But I think the way they balance out changes depending on the place.

In Kazakhstan, it seems like reflective autonomy is the main way teachers build their identity. Over in China, empathy and that sense of group awareness play a bigger role in building moral resilience and how they handle relationships. This makes me think the overall setup for growing socio-cognitively is pretty much the same everywhere, but how it shows up culturally depends on the context. So educational systems in these countries can end up with teachers who are self-regulated and responsible socially, even if they take different paths to get there. That part stands out because it is not always straightforward. For teacher education programs, the findings suggest some changes in how they are designed. Curricula need to mix in reflective parts, intercultural elements, and socio-emotional training so students get a full experience of growth. It feels like that would help a lot. Then there is international collaboration, which should not just be about swapping students but also joint mentoring, research across schools, and places for talking about cultures to keep development going long term. Both sides could pick up

tips from each other, like Kazakhstan learning Chinas way of training collective empathy, and China getting ideas from Kazakhstans student-focused reflective teaching. This gets a bit messy when you think about applying it, but it seems worth trying.

This study pushes forward our ideas about how people develop socially and cognitively, especially when you look at it through the lens of higher education across different cultures. I think its a step toward seeing things in context, like in places such as Kazakhstan and China. The main thing here is this model they came up with, the one in Figure 2, which tries to tie together cognitive stuff and emotional parts. It works through things like reflecting on experiences and interacting with other cultures. Personal growth doesnt just happen inside someones head on their own, but it comes from jumping into social and cultural setups that keep changing.

That model helps connect Western ways of thinking about cognitive growth with Eastern views on moral and emotional learning. It makes teacher training feel more complete for todays world, the 21st century kind of thing. Some parts of this might overlap a bit, but it seems to fill in gaps that were there before. When you compare the two countries, Kazakhstan and China, you see socio-cognitive skills driving personal and job-related growth everywhere, but how much they matter or show up changes with the culture. Even though their educational ideas differ, both end up aiming for teachers who reflect, show empathy, and handle intercultural stuff well. Those are key for education thats global now, I suppose. The comparison highlights that convergence, though it gets a bit messy in the details.

Conclusion. The research I looked at basically shows how socio-cognitive stuff plays a big role in helping future teachers grow personally and professionally, especially in these international and cross-cultural school settings. When they compared Kazakhstan and China, there were some common patterns but also differences based on each place. It seems like metacognitive regulation, emotional intelligence, empathy, and intercultural

awareness all connect and predict how students develop. The numbers from the analysis suggest these things explain about half of the changes in self-reflection and adapting for students. That makes sense because it ties together how socio-cognitive parts work in teacher training.

In Kazakhstan, they focus more on reflective autonomy and self-regulating thoughts, which fits with their push for modernizing education and building competencies. Over in China, its different, with more emphasis on empathy, group thinking, and moral duties, coming from that Confucian ideas and the way they learn together. Still, both sides end up building teachers who can reflect critically, handle emotions well, and understand other cultures. International learning spots really boost this socio-cognitive growth by pushing intercultural talks, more self-awareness, and ways to adapt. Things like joint projects, teaching in two languages, or exchanges help widen views and make people feel more realized in their careers. Intercultural experiences arent just background,

they change how teaching happens and speed up maturity.

The model they suggest pulls in cognitive, emotional, and social sides of teacher growth, and it could help improve programs in both countries. It shows becoming a good teacher isnt straight line, but more interactive through reflection, empathy, and talking across cultures. I think that part gets a bit messy to explain fully. The study had limits, like the sample size and how long the intercultural stuff lasted. Maybe future work could look at more areas, track people over time, see how these factors change. Also, adding digital platforms for online teaming might show new things about forming teacher identities globally. Overall, this adds to knowing how socio-cognitive development mixes culture, thinking, and education. Kazakhstan and Chinas examples show different teaching ways, in an international setup, can aim for the same thing, preparing teachers who reflect, empathize, and handle global education challenges. That stands out, but its not everything.

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