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Foreign Experiences In Developing Research Competencies Of Prospective Teachers Through Digital Technologies

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Abstract: This article analyzes foreign experiences in the use of digital technologies for developing research competencies among prospective teachers. In the context of the 21st-century digital transformation of education, teacher education systems require future educators to engage in scientific inquiry, critical thinking, and innovative approaches to teaching and learning. The study scientifically substantiates the role of technologies such as Artificial Intelligence (AI), Machine Learning, Big Data Analytics, and Network Analysis in enhancing the research potential of future teachers. In particular, the capabilities of interactive platforms such as Mentimeter, Kialo Edu, Sciwheel, and Zotero AI plugins are highlighted as effective tools for fostering competencies in scientific inquiry, logical reasoning, source management, evidence-based analysis, and reflective thinking.

Keywords: Prospective teachers, research competencies, digital technologies, artificial intelligence, big data, machine learning, interactive platforms, international experience, research literacy.

Introduction: In the 21st century, the rapid digital transformation taking place in the field of education has fundamentally changed the requirements for teacher preparation worldwide. Under the influence of globalization and technological advancement, the modern educator is no longer perceived merely as a transmitter of knowledge, but as an innovative researcher capable of critical thinking, conducting scientific inquiry, and solving creative problems.

This paradigmatic shift necessitates the deep integration of research competencies into teacher education systems, positioning scientific inquiry as a key component of teachers' professional development.

Contemporary international educational frameworks - notably the OECD Learning Compass 2030 and UNESCO's Education for Sustainable Development (ESD) framework - emphasize the urgent need to foster research competencies, digital literacy, and innovative thinking among prospective teachers.

The digital revolution in education has created unprecedented opportunities for developing research competencies through the use of Artificial Intelligence (AI), Machine Learning, Big Data Analytics, and interactive learning platforms.

These technologies are elevating pedagogical education to a new level, responding to the exponential growth of scientific data, the increasing complexity of educational research methodologies, and the rising demand for evidence-based teaching practices.

International experience demonstrates that countries with well-developed digital research infrastructure and systematically integrated technology within teacher training programs achieve higher levels of research productivity and educational innovation.

Scholars have offered diverse perspectives on the concept of "research technology". For instance, U. Göbel and W. Schlafke define research technology as an integrated system that manages the processes of creating, transmitting, processing, and utilizing scientific information through modern information and communication tools [3].

Similarly, T. Bates interprets research technology as a method of collecting, analyzing, and disseminating data using digital tools, emphasizing that such technologies significantly expand the transparency, scope, and accessibility of scientific research [11]

The term "technology" (educational technology, technology in education) derives from the Latin words *techne* ("skill," "art") and *logos* ("study," "discourse"). In pedagogical literature, it is interpreted as a scientifically grounded system that harmoniously integrates and manages all components of the educational process. Such a system encompasses goal-oriented, time- and space-coordinated educational and informational resources, ensuring the achievement of intended learning outcomes.

Within the European pedagogical system, the concept of research technology encompasses the following key dimensions:

- effective use of diverse forms and methods of scientific inquiry;
- development of methodological thinking among students;
- implementation of individualized approaches to research activities;
- fostering students' active participation in creative and exploratory learning.

This technology is expected to align with modern educational standards by meeting the following criteria:

- correspondence to the stages of scientific and professional development;
- compliance with the core principles of humanistic pedagogy;
- prioritization of interactive forms of self-learning and self-development;
- extensive and effective integration of information and communication technologies (ICT) into the research process [4].

In today's global context, as education and research activities undergo rapid digitalization, technologies such as Artificial Intelligence (AI), Machine Learning (ML), Big Data, and Network Analysis have become integral tools of the modern research process. These technologies are transforming the ways in which scientific knowledge is created, processed, visualized, and disseminated. Their potential is particularly significant in preparing prospective teachers for research-oriented and evidence-based professional practice.

First, AI-driven tools simplify the research process by automating data collection, classification, analysis, and model generation. Through features such as semantic analysis of research papers, identification of inter-citation relationships, and topic recommendation, AI accelerates research workflows and reduces repetitive tasks. Platforms such as ChatGPT, Scite.ai, ResearchRabbit, Elicit, and Iris.ai enable students and researchers to organize literature reviews more efficiently and critically.

Machine Learning (ML), in turn, is widely used in pedagogical experiments and empirical studies for building statistical models, predicting outcomes, and automatically identifying relationships among variables. Using ML algorithms, large datasets of student-related information — including test results, assessment indicators, and reflective writings — can be analyzed to infer patterns in cognitive development or learning strategy effectiveness. This enhances the autonomy and analytical depth of research-based decision-making.

The concept of Big Data encompasses vast, continuously updated, and multi-format information. In education,

big data tools enable the analysis of all digital traces generated throughout the learning process. For example, data on students' engagement in virtual classes, task completion rates, and learning pace can be aggregated into analytical models that help researchers better understand individual learning trajectories.

As defined by international scholars, Big Data refers to activities that can only be performed at a large scale — actions that produce new knowledge or create new forms of value — and that drive profound transformations across domains such as markets, organizations, civic life, and governance [6].

Finally, Network Analysis technology provides powerful means for examining scientific collaboration patterns, citation networks, knowledge transmission channels, and intellectual hubs. It allows for the visualization of inter-university or cross-national research relationships and the identification of trending topics within specific academic domains. In the context of teacher education, network analysis fosters the development of scientific thinking, collaboration, and research culture among future educators.

Moreover, these technologies contribute significantly to the formation of scientific culture, the development of critical thinking, and the improvement of information literacy among students. With the help of AI and Big Data tools, students can not only substantiate their research with empirical evidence but also derive new insights through digital means. This, in turn, enhances their motivation for scientific inquiry and fosters a more reflective and self-directed learning approach.

According to studies conducted at universities across Europe and North America, the implementation of AI technologies has substantially improved the analytical thinking, data-handling, and evidence-based decision-making competencies of preservice teachers [7], [9]. In particular, AI-powered interactive platforms such as Mentimeter, Kialo Edu, Sciwheel, and the Zotero AI plugin have simplified the research process while increasing students' enthusiasm for independent exploration.

In both large lecture halls and small seminar settings, maintaining student engagement and ensuring interactivity has long been a challenge. From this perspective, tools such as Mentimeter—which allow students to respond to instructor prompts in real time and anonymously via personal digital devices (mobile phones, tablets, or laptops)—have proven highly effective. Such platforms promote inclusive learning environments, enhance teacher-student interaction,

and improve the overall positive experience of the learning process [5].

According to research conducted by Mayhew et al., students who used Mentimeter reported significantly higher levels of satisfaction and enjoyment during class. Moreover, the tool helped maintain a high level of concentration and attention. As students themselves noted:

“It’s engaging and energizing — instead of just sitting and listening, interacting directly with instructors helps us focus more easily.” [5]

The process of conducting interactive presentations through the Mentimeter platform begins when the instructor shares slides created on the www.mentimeter.com website in real time during a classroom session or virtual meeting. The platform integrates seamlessly with digital whiteboards, projectors, and video conferencing systems, simplifying the overall presentation process.

Students join the interactive session via their personal devices (smartphones, tablets, or laptops) by visiting www.menti.com and entering a unique access code provided by the instructor. No registration or personal account is required, which ensures that the platform remains user-friendly and inclusive, allowing all participants to engage easily in the learning activity.

For these technologies to be implemented effectively, both teachers and students must possess a high level of digital literacy and information technology competence. Consequently, leading higher education institutions worldwide have introduced specialized modules such as “Data Literacy,” “Digital Research Methods,” and “AI and Education” aimed at developing digital research skills and fostering data-driven inquiry among preservice teachers [5].

Another notable interactive platform that promotes critical thinking, argumentation culture, social empathy, and communication competence in modern education is Kialo Edu. While Mentimeter engages students through short, real-time responses, Kialo Edu focuses on developing structured debate, logical reasoning, and in-depth analytical discussion skills.

The Kialo Edu platform enables users to construct reasoning based on an “argument tree” model, where the main thesis is surrounded by supporting (pro) and opposing (con) arguments, organized in logically coherent layers. This structure enhances students' abilities to articulate ideas coherently, classify evidence, and formulate sub-arguments effectively [1].

Its interactive and visually engaging format motivates learners to participate actively. Students can vote on arguments, cite sources, and evaluate the strength or

relevance of different claims. Such a model fosters a deeper understanding of the principles of scientific reasoning, objectivity, and reflective analysis, which are essential for the development of research competence in future educators.

The Kialo Edu platform fosters the development of research competence through its use in various educational and analytical activities, including:

- Pre-research preparation: students construct “argument trees” through discussions, organizing key arguments for research essays or articles;
- Ethical issues in STEM disciplines: evidence-based reasoning is developed around topics such as artificial intelligence, biotechnology, and environmental challenges;
- Literary analysis: during literature lessons, character motivations and plot interpretations are explained using structured argument maps;
- Decision-making practice: students formulate and justify optimal solutions to real-world social problems through argumentative reasoning;
- Small-group debates: mixed-ability groups conduct independent inquiry on their personalized discussion pages.

Through these practices, Kialo Edu not only cultivates a culture of structured argumentation and dialogue but also serves as an effective methodological tool for enhancing students’ research competence by promoting analytical, reflective, and evidence-based thinking.

In addition to interactive debate platforms, modern digital research tools such as Sciwheel and the Zotero AI plugin also play a significant role in developing research-oriented skills among students.

Sciwheel is a cutting-edge digital library designed for researchers, enabling users to organize, annotate, and automatically generate bibliographic references. Through this system, students can categorize scientific articles by topic, write annotations for reviewed sources, and format citations in various international styles (APA, MLA, Chicago, etc.).

Importantly, Sciwheel facilitates the thematization and comparative analysis of academic literature, allowing students to build a robust theoretical foundation for their research projects. This process enhances their abilities in data management, logical reasoning, academic writing, and argument-based analysis [8].

The Zotero AI plugin, an artificial intelligence-based assistant integrated within the Zotero platform, provides efficient support in working with academic texts. Through this plugin, students can summarize

scholarly articles, extract key theses and arguments, engage in question-answer reflection, and perform comparative analyses with related studies. This process prepares learners for research activities grounded in critical thinking, argumentation, evidence-based reasoning, source literacy, and metacognitive awareness [10].

Using these platforms, students develop the ability to conduct independent research, gather and analyze evidence, synthesize ideas, respond to academic questions, and produce scholarly outputs such as essays and reports. Notably, the automation of bibliographic citation, prevention of plagiarism, and enhancement of source management culture make these tools highly effective in academic writing and research training.

According to European scholars, the global volume of scientific and technical information is increasing by an average of 13% annually, resulting in a doubling every 5.5 years. Forecasts suggest that with the growing number of researchers and the emergence of advanced data acquisition systems, this figure may soon rise to 40%, meaning that by 2025, the total amount of scientific data is expected to double every 73 days [2].

In this context, modern technologies create opportunities for students to test their hypotheses, visualize and present research data interactively, and engage in learning environments aligned with their cognitive needs. Consequently, these digital tools strengthen their competencies in independent inquiry, data presentation, and digital literacy, while simultaneously contributing to the innovative development of the entire education system.

In conclusion, the analysis of international experience demonstrates that the development of research competence among preservice teachers can be effectively achieved through the deep integration of digital technologies into the educational process. The use of artificial intelligence, machine learning, big data analytics, and interactive learning platforms fosters analytical thinking, argumentation culture, and scientific communication skills.

Digital tools such as Mentimeter, Kialo Edu, Sciwheel, and the Zotero AI plugin play a critical role in individualizing research activities, promoting logical reasoning, and cultivating academic integrity and information management literacy.

The findings indicate that the systematic incorporation of digital research technologies into teacher education programs significantly enhances educational quality, research productivity, and innovation capacity. Therefore, introducing new courses such as “Digital Research Methods” and “AI in Education”, developing nationally adapted digital platforms, and expanding

international collaborations in research are essential priorities for the future development of Uzbekistan's teacher education system.

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