

ADVANTAGES AND CHALLENGES IN DEVELOPING DIGITAL PEDAGOGICAL COMPETENCE OF HIGHER MATHEMATICS TEACHERS

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Abstract

This article provides a scientific analysis of the achievements and existing challenges in the development of digital pedagogical competence among higher mathematics teachers working in higher education institutions. The process of digitalization has brought fundamental changes to the education system, and the importance of using digital tools, especially in teaching exact sciences, is substantiated.

Keywords: Digital pedagogy, higher mathematics, competence, information technologies, distance education, innovative methods, didactic design.

Introduction

In the 21st century, the digital transformation of society has significantly influenced the education system. The process of teaching mathematics in higher education institutions is gradually shifting from traditional approaches to systems based on digital didactic models. Since higher mathematics is based on complex abstract concepts, theoretical proofs, and formal logical structures, the use of digital tools plays a particularly important role in its effective teaching.

Digital competence in the pedagogical context consists of technological, didactic, and communicative components, as substantiated in the TPACK and DigCompEdu frameworks. Digital pedagogical competence is defined as the ability of a teacher to purposefully and effectively use information and communication technologies (ICT) in designing, organizing, and assessing the educational process. For higher mathematics teachers, this competence includes not only technical skills but also didactic, methodological, and reflective capacities.

The purpose of this article is to systematically analyze the main achievements and shortcomings in the development of digital pedagogical competence of higher mathematics teachers and to justify ways of overcoming them.

1. Theoretical Foundations of Digital Pedagogical Competence

1.1. Concept of Digital Competence

Digital competence is a set of knowledge, skills, and attitudes related to selecting, applying, evaluating, and integrating digital technologies. In the pedagogical context, it includes:

Technological competence (use of software and platforms);

Didactic competence (adapting digital tools to learning objectives);

Communicative competence (organizing online communication and collaboration);
Information security and ethical responsibility;
Digital reflection and innovative thinking.

1.2. Specific Features of Teaching Higher Mathematics

Higher mathematics is characterized by:

Formality and strict logical structure;

Culture of proof;

Modeling and abstraction;

The necessity of graphical and visual analysis.

Therefore, the use of tools such as GeoGebra, MATLAB, Wolfram Mathematica, and Python enables the delivery of mathematical concepts in a visual and interactive format.

2. Achievements in Developing Digital Pedagogical Competence

2.1. Increased Interactivity of the Learning Process

Digital tools allow the visualization of topics such as differential equations, linear algebra, and integral calculus through animations. For example, dynamically modifying the graph of a function helps students better understand concepts such as limits and derivatives.

2.2. Implementation of Distance and Blended Learning Systems

The development of distance and blended learning systems is one of the key factors in shaping digital pedagogical competence. During the pandemic:

Experience in preparing video lectures was developed;

Online testing systems were introduced;

Electronic educational resources were significantly expanded.

2.3. Opportunities for Individualized Learning

Digital platforms enable monitoring students' learning progress. Through adaptive testing systems, tasks can be assigned according to each student's level of knowledge.

2.4. Integration with Scientific Research

Digital tools accelerate scientific calculations. Teachers can demonstrate real mathematical models during lessons, ensuring integration between theory and practice.

3. Challenges in Developing Digital Competence

3.1. Technological Inequality

In some regional higher education institutions:

Low internet speed;

Lack of modern computer equipment;

Limited access to licensed software are observed.

3.2. Insufficient Methodological Preparation

Many teachers can technically use digital platforms but lack knowledge of how to apply them effectively for didactic purposes. As a result, digital tools are often reduced to simple presentation tools.

3.3. Psychological Barriers

Among experienced teachers:

Distrust toward digital technologies;
Resistance to abandoning traditional teaching methods;
Fear of making mistakes are common.

3.4. Problems in Assessment Systems

Academic integrity remains a critical issue in online assessment. In mathematics, it becomes difficult to monitor students' independent problem-solving processes.

4. Ways to Overcome the Challenges

4.1. Continuous Professional Development Model

To develop digital pedagogical competence:

Specialized training courses;
Workshops and training sessions;
Mentorship systems should be implemented.

4.2. Development of Methodological Resources

For higher mathematics:

Digital lesson scenarios;
Interactive task banks;
Electronic laboratory materials should be developed.

4.3. Infrastructure Modernization

Providing educational institutions with high-speed internet and modern technical equipment should be a priority.

4.4. Improving Academic Integrity Mechanisms

The issue of ensuring academic integrity in online assessment systems is widely recognized as a critical challenge. It is advisable to implement:

Proctoring systems;
Open-ended problem-based tasks;
Oral online defense formats.

5. Scientific Analysis and Discussion

The formation of digital pedagogical competence is a systematic process that includes the following stages:

Digital literacy;

Digital integration;
Innovative transformation.

The professional model of a higher mathematics teacher should evolve into a specialist capable of operating freely in a digital environment, creating content, and independently designing didactic processes.

Conclusion

The results of the study indicate that significant progress has been achieved in developing the digital pedagogical competence of higher mathematics teachers. In particular, increased interactivity of the learning process, expansion of distance education opportunities, and the development of individualized learning approaches are notable achievements.

However, infrastructure limitations, insufficient methodological preparation, and psychological barriers remain significant challenges. These issues can be addressed through continuous professional development, methodological support, and the formation of a digital culture.

In the context of digital transformation, the digital pedagogical competence of higher mathematics teachers should be considered one of the key indicators of education quality.

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