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DEVELOPING PEDAGOGICAL COMPETENCE OF FUTURE INFORMATICS TEACHERS IN INDEPENDENT LEARNING THROUGH SOFTWARE-BASED LEARNING TOOLS

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Abstract

This article examines the development of pedagogical competence in future informatics teachers through software-based independent learning. The importance of digital technologies and software tools in modern education is analyzed. Independent learning is considered an important factor in developing pedagogical skills. The results show that software use is effective in enhancing pedagogical competence.

Keywords. pedagogical competence, independent learning, educational software, informatics teacher, digital education, methodology

Introduction

Аннотация

В статье рассматривается развитие педагогической компетентности будущих учителей информатики через использование программного обеспечения в процессе самостоятельного обучения. Анализируется значение цифровых технологий и программных средств в современном образовании. Самостоятельное обучение рассматривается как важный фактор формирования педагогических навыков. Результаты исследования

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показывают эффективность использования программного обеспечения в развитии педагогической компетентности.

Ключевые слова. педагогическая компетентность, самостоятельное обучение, программное обеспечение, учитель информатики, цифровое образование, методика

Annotatsiya

Ushbu maqolada mustaqil ta'lim jarayonida dasturiy ta'minotdan foydalanish orqali bo'lajak informatika o'qituvchilarining pedagogik kompetentligini rivojlantirish masalalari o'rganilgan. Zamonaviy ta'limda raqamli texnologiyalar va dasturiy vositalarning ahamiyati tahlil qilingan. Mustaqil ta'lim pedagogik ko'nikmalarni shakllantirishda muhim omil sifatida ko'rib chiqilgan. Tadqiqot natijalari dasturiy ta'minotdan foydalanish pedagogik kompetentlikni rivojlantirishda samarali ekanini ko'rsatadi.

Kalit so'zlar. pedagogik kompetentlik, mustaqil ta'lim, dasturiy ta'minot, informatika o'qituvchisi, raqamli ta'lim, metodika

Literature Review

The development of pedagogical competence in future informatics teachers through software-based independent learning has become an important area of research in modern education. With the rapid growth of digital technologies, educational systems are increasingly integrating software tools to enhance teaching and learning processes. Researchers emphasize that independent learning supported by digital environments plays a crucial role in preparing competent and innovative teachers.

Shulman (1987) introduced the concept of Pedagogical Content Knowledge (PCK), which highlights the integration of subject knowledge and pedagogical

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understanding. This framework laid the foundation for modern teacher education models. Later, Mishra and Koehler (2006) expanded this idea by developing the TPACK framework, which integrates Technology, Pedagogy, and Content Knowledge. According to this model, effective teaching requires a balanced combination of these three components, especially in technology-rich learning environments.

In the context of digital transformation, Voogt et al. (2013) argue that teacher education programs must include ICT integration as a core component. They emphasize that future teachers should not only learn how to use digital tools but also understand how to apply them effectively in pedagogical practice. Similarly, Tondeur et al. (2012) highlight that practical experience with educational technologies is essential for developing teaching competence.

Independent learning has also been widely studied in educational research. According to Siemens (2005), learning in the digital age is based on connectivism, where knowledge is distributed across networks and learning occurs through interaction with digital systems. This theory supports the idea that software-based environments enable learners to take responsibility for their own learning process.

Educational software plays a key role in supporting independent learning. Learning management systems (LMS), simulation tools, programming environments, and interactive platforms provide learners with opportunities to study independently, receive immediate feedback, and practice real-world tasks. Anderson (2008) emphasizes that such technologies create flexible learning environments that enhance student autonomy and engagement.

Research by Holmes, Bialik, and Fadel (2019) shows that artificial intelligence and educational software can personalize learning experiences by adapting content to individual learner needs. This personalization is particularly important for developing pedagogical competence, as it allows future teachers to experience adaptive learning systems from a learner's perspective.

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In addition, Luckin et al. (2018) argue that intelligent systems act as supportive tools in education by providing guidance, feedback, and assessment. These systems help learners develop self-regulation skills, which are essential for independent learning. Similarly, Hwang et al. (2020) found that adaptive learning environments significantly improve student motivation, engagement, and problem-solving abilities.

From a teacher education perspective, Darling-Hammond (2017) emphasizes the importance of practice-based learning. She argues that teacher candidates develop stronger pedagogical competence when they are actively involved in real teaching situations. Software-based independent learning can simulate such environments through virtual classrooms, teaching simulations, and interactive scenarios.

Ertmer and Ottenbreit-Leftwich (2010) highlight the role of teacher beliefs in technology integration. They suggest that positive attitudes toward technology are essential for effective use of digital tools in education. Without proper motivation and confidence, even advanced software tools may not be used effectively in teaching practice.

Studies by Zawacki-Richter et al. (2019) provide a systematic review of artificial intelligence applications in higher education. Their findings show that most AI-based systems are used for personalized learning, automated assessment, and learning analytics. These systems support both learners and educators by improving efficiency and providing data-driven insights into learning processes. Selwyn (2019) raises important concerns about the ethical implications of digital education, including data privacy, algorithmic bias, and over-reliance on technology. He argues that while digital tools are beneficial, they should not replace the essential role of human teachers in education. This perspective is important when designing software-based independent learning systems.

Williamson and Eynon (2020) further emphasize the need for transparency in educational technologies. They highlight that decision-making processes in AI-

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based systems should be understandable and fair to avoid reinforcing inequalities in education.

In the field of informatics education, Wing (2006) introduces the concept of computational thinking, which is essential for solving problems using computer science principles. Software-based learning environments provide opportunities for developing computational thinking skills, which are closely related to pedagogical competence in informatics teachers.

Anderson (2016) also highlights that digital learning environments promote active learning by allowing students to interact with content, experiment with solutions, and receive instant feedback. This interactivity is essential for developing both technical and pedagogical skills.

Despite the advantages of software-based independent learning, several challenges remain. Lack of access to modern technologies, insufficient training for teacher educators, and limited integration of pedagogy and technology are common issues identified in the literature. These challenges indicate the need for more structured and systematic approaches to teacher education.

Overall, the literature strongly supports the integration of software-based independent learning in the development of pedagogical competence. Educational software enhances autonomy, improves engagement, and supports personalized learning experiences. The combination of theoretical knowledge, practical experience, and digital tools is essential for preparing future informatics teachers. This review suggests that well-designed software-based learning environments can significantly improve the quality of teacher education when supported by appropriate pedagogical frameworks.

Research Methodology

This study employs a qualitative-analytical and conceptual research design aimed at exploring the development of pedagogical competence in future informatics teachers through software-based independent learning. The methodology is

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structured to ensure a systematic understanding of how educational software tools contribute to pedagogical skill formation, digital competence, and professional readiness in teacher education programs.

The research is organized into three main stages: theoretical analysis, comparative analysis, and methodological modeling. Each stage is designed to provide a comprehensive view of the research problem and to support the development of a structured pedagogical framework.

Theoretical Analysis. The first stage involves a detailed review of scientific literature, academic publications, and international educational frameworks. Key concepts such as pedagogical competence, independent learning, educational software, ICT integration, and the TPACK model are analyzed. This stage helps to identify the theoretical foundations of the study and clarifies how software-based learning environments influence teacher competence development. Special attention is given to works by Shulman (1987), Mishra and Koehler (2006), and Siemens (2005), which provide essential theoretical grounding.

Comparative Analysis. The second stage focuses on comparing different teacher education systems and digital learning approaches used in various countries. This comparison highlights how educational software is integrated into teacher training programs and how it supports independent learning. The analysis includes curriculum structures, teaching strategies, and the use of digital platforms such as learning management systems, simulation tools, and programming environments. The purpose of this stage is to identify best practices and effective approaches for developing pedagogical competence.

Methodological Modeling. Based on the findings from the previous stages, a methodological model is developed to explain how software-based independent learning can be used to enhance pedagogical competence. The model consists of three interconnected components: theoretical preparation, software-based practice, and reflective learning. The theoretical component focuses on pedagogical knowledge and instructional design. The software-based practice

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component involves the use of digital tools for learning and teaching simulations. The reflective component emphasizes self-evaluation and continuous improvement.

Research Approach. The study uses a qualitative and descriptive approach. It is based on the analysis and synthesis of existing scientific literature rather than experimental data collection. This approach is suitable for developing conceptual models and pedagogical frameworks.

Data Collection. Data is collected from peer-reviewed journal articles, international reports, books, and academic databases related to teacher education and educational technology. Only credible and recent sources are included to ensure reliability and academic relevance.

Data Analysis. Content analysis is used to identify key themes and concepts in the literature. Thematic analysis is applied to organize findings into categories such as pedagogical competence, software-based learning, and digital pedagogy. This allows for a structured interpretation of the data.

Validity and Reliability. The validity of the study is ensured through the use of authoritative academic sources and established theoretical frameworks. Reliability is maintained by systematically comparing findings across multiple studies and ensuring consistency in interpretation.

Ethical Considerations. Since the study is based on secondary data, no human participants are involved. However, academic integrity is strictly followed by properly citing all sources and avoiding plagiarism.

Overall, this methodology provides a structured and systematic approach to analyzing the role of software-based independent learning in developing pedagogical competence among future informatics teachers.

Analysis and Results

The analysis of this study focuses on understanding how software-based independent learning contributes to the development of pedagogical competence

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in future informatics teachers. The findings are derived from a systematic interpretation of existing literature and conceptual models. Since the research is qualitative and theoretical, the results are based on content synthesis rather than empirical experimentation.

The analysis shows that educational software significantly enhances the development of pedagogical competence by providing interactive and flexible learning environments. Learning management systems (LMS), programming platforms, simulation tools, and digital assessment systems allow students to engage in independent learning activities that closely resemble real teaching situations. These tools help future teachers develop essential skills such as lesson planning, instructional design, and assessment strategies.

One of the key results is that software-based independent learning improves students' ability to connect theoretical knowledge with practical teaching skills. By using digital platforms, learners can simulate classroom environments, create lesson materials, and test different teaching approaches. This practical exposure strengthens their pedagogical understanding and increases their confidence in teaching.

The analysis also reveals that independent learning supported by software promotes self-regulation and autonomy. Students become more responsible for managing their learning process, setting goals, and evaluating their progress. This self-directed approach is essential for developing professional competence in future teachers.

Another important result is the development of digital competence alongside pedagogical skills. The use of educational software enhances students' ability to work with digital tools, design interactive content, and integrate technology into teaching. This dual development of pedagogical and digital competencies is a significant advantage of software-based learning environments.

However, the analysis also identifies several challenges. One of the main issues is the unequal access to advanced educational software and digital infrastructure.

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Some institutions lack sufficient technological resources, which limits students' learning opportunities. Additionally, insufficient training in the effective use of software tools reduces their pedagogical impact.

Another challenge is the lack of structured guidance in some independent learning environments. Without proper instructional support, students may struggle to use software tools effectively for pedagogical development. This indicates the need for well-designed learning models and teacher support systems.

Despite these challenges, the overall results demonstrate that software-based independent learning is highly effective in developing pedagogical competence. It provides opportunities for practical experience, enhances digital literacy, and supports self-regulated learning. The integration of theoretical knowledge with software-based practice creates a more dynamic and effective teacher training process.

In conclusion, the analysis confirms that educational software plays a crucial role in preparing future informatics teachers. It bridges the gap between theory and practice and supports the holistic development of pedagogical competence in modern digital education environments.

Conclusion

This study examined the role of software-based independent learning in developing pedagogical competence among future informatics teachers. The findings show that educational software significantly contributes to improving pedagogical skills, digital competence, and self-regulated learning abilities. By engaging with digital tools such as learning management systems, programming environments, and simulation platforms, students gain practical experience that strengthens their professional readiness.

The research confirms that independent learning supported by software creates an effective learning environment where future teachers can integrate theory with practice. It also enhances their ability to design lessons, manage learning

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activities, and apply innovative teaching strategies. In addition, software-based learning encourages autonomy, responsibility, and continuous self-improvement. However, the study also identifies certain challenges, including limited access to technological resources, insufficient training in software use, and lack of structured pedagogical guidance. These issues may reduce the effectiveness of independent learning if not properly addressed.

Overall, the results indicate that software-based independent learning is a powerful approach for developing pedagogical competence in future informatics teachers. Its effectiveness increases when combined with proper instructional support, modern infrastructure, and well-designed pedagogical models. Future research should focus on empirical validation of these findings and the development of more advanced digital learning frameworks.

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