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AI-SUPPORTED DIGITAL-DIDACTIC TECHNOLOGY FOR MONITORING AND DEVELOPING METHODOLOGICAL COMPETENCE OF FUTURE PHYSICS AND ASTRONOMY TEACHERS

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Abstract

This article describes an AI-supported digital-didactic technology for developing and monitoring the methodological competence of future physics and astronomy teachers. The technology is based on the MethodEdu.uz adaptive digital learning platform described in the dissertation plan. The aim of the article is to define the functional roles, learning algorithm, AI support mechanisms, competence map, portfolio evidence, and assessment logic of the platform. The study uses a design-based methodological approach and treats the platform as a digital-didactic environment that connects electronic modules, interactive assignments, virtual laboratories, diagnostic testing, adaptive recommendations, teacher feedback, and responsible AI assistance. The results present a staged technology: initial diagnostics, competence profiling, integrated module completion, methodological task performance, AI and teacher feedback, competence map updating, portfolio accumulation, adaptive recommendation, and final diagnostics. The article also proposes a monitoring matrix based on tests, task completion, portfolio quality, AI-use history, teacher confirmation, and competence levels. The discussion emphasizes that AI should support methodological thinking but should not replace pedagogical judgment; final assessment must be confirmed by the teacher or expert. The article concludes that MethodEdu.uz can become a reliable digital-didactic mechanism for individualized, evidence-based, and reflective development of future physics and astronomy teachers' methodological competence.

Keywords: MethodEdu.uz; AI assistant; digital-didactic technology; methodological competence; competence map; portfolio; adaptive assessment; physics teacher education.

Introduction

The rapid development of digital learning environments has changed the requirements for teacher education. Future physics and astronomy teachers need to be prepared not only for traditional classroom instruction, but also for digital lesson design, virtual laboratory organization, online assessment, data-based reflection, and responsible use of AI-supported tools. Methodological competence in this context becomes a multidimensional ability that includes pedagogical reasoning, subject-methodological action, digital tool use, communication, assessment, and reflection.

Physics and astronomy are particularly suitable for digital-didactic support because many phenomena can be modeled, visualized, measured, and discussed through interactive technologies. Virtual laboratories make it possible to observe processes that are difficult, dangerous, or expensive to organize in a traditional classroom. AI assistants can provide guiding questions, alternative explanations, feedback on draft lesson plans, and suggestions for interdisciplinary links. However, these tools must be integrated into a pedagogically responsible system.

The dissertation plan proposes MethodEdu.uz as an adaptive platform with electronic modules, diagnostic tests, virtual laboratories, competence maps, portfolios, AI assistant, AI content generator, monitoring, and exportable reports. The platform is intended to support the integration of General Pedagogy and the Methodology of Teaching Physics and Astronomy. This article focuses on the technology of methodological competence development and monitoring within such a platform.

The purpose of the article is to describe how AI-supported digital-didactic technology can organize the learning trajectory of future physics and astronomy teachers. Special attention is paid to the responsible role of AI: it can assist, recommend, and provide preliminary analysis, but it should not make final pedagogical judgments or replace teacher assessment.

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Literature Review

Digital competence frameworks emphasize that educators should be able to select digital resources, organize digital communication, assess learners through digital tools, and support self-regulated learning. For future physics teachers, this means that digital resources must be selected according to the physical phenomenon, learning goal, learner difficulty, and assessment method. A virtual laboratory or AI-generated task is useful only when it serves a clear didactic function.

Adaptive learning environments are based on the idea that students should receive tasks and recommendations according to their individual progress. In teacher education, adaptivity can be organized not only around test scores but also around the quality of methodological products. For instance, if a student's lesson plan has weak assessment criteria, the system may recommend materials on rubrics, diagnostic tasks, and formative feedback. If the virtual laboratory analysis is weak, the system may recommend additional examples of experiment-based teaching.

The use of AI in education creates new opportunities and new risks. AI can generate draft test items, suggest guiding questions, summarize portfolio reflections, and identify possible weaknesses in a methodological product. At the same time, AI-generated advice may be incomplete, inaccurate, or context-insensitive. Therefore, responsible AI use requires transparency, teacher moderation, privacy protection, and human confirmation of final decisions.

In the context of physics and astronomy teacher education, AI support should be understood as a methodological assistant rather than an automatic evaluator. The main educational value is not that AI gives an answer, but that it helps students ask better questions, compare alternatives, improve lesson design, and reflect on their own professional choices.

Methodology and research design

Research design: The article is a design-based methodological study. It develops the structure of an AI-supported digital-didactic technology for MethodEdu.uz and explains how the technology can be used to develop and monitor methodological competence. The study is based on the integration logic of General Pedagogy and the Methodology of Teaching Physics and Astronomy.

Functional analysis: The platform was analyzed through five user roles: administrator, teacher or tutor, student, expert or scientific supervisor, and AI administrator or moderator. Each role has a specific pedagogical function. The administrator manages access and technical structure; the teacher creates modules, tasks, and rubrics; the student completes assignments and maintains a portfolio; the expert reviews quality and research evidence; the AI administrator controls safe and appropriate AI behavior.

Technology algorithm: The proposed algorithm includes initial diagnostics, competence profile creation, selection of integrated modules, completion of methodological assignments, AI-supported consultation, teacher feedback, competence map updating, portfolio accumulation, adaptive recommendation, and final diagnostics. The algorithm is cyclic because results from one stage influence the next recommendation.

Assessment logic: Methodological competence is monitored through a combination of quantitative and qualitative evidence. Quantitative evidence includes diagnostic test results, task completion rate, activity frequency, and progress by components. Qualitative evidence includes lesson plans, case solutions, virtual laboratory analyses, PISA-type tasks, STEAM projects, reflective notes, and teacher comments. AI may provide preliminary analysis, but the final pedagogical assessment is confirmed by the teacher or expert.

Research Results

The first result is a staged model of AI-supported digital-didactic technology. The model begins with initial diagnostics that identify the student's starting level in pedagogical knowledge, subject methodology, digital-methodological readiness, and diagnostic-reflective ability. On this basis, the platform creates a competence profile and recommends the first set of integrated modules.

The second result is the definition of the AI assistant's functions. In MethodEdu.uz, the AI assistant may act as a methodological consultant, question generator, content draft generator, open-answer analyzer, portfolio reflection assistant, interdisciplinary connection suggester, and language-style helper. These functions are designed to support learning, not to replace professional judgment. The AI assistant must provide guiding questions and alternative suggestions rather than final ready-made decisions.

Table 1 Monitoring matrix for AI-supported methodological competence development in MethodEdu.uz.

Technology stage	Digital evidence	Competence indicator	Human decision
Initial diagnostics	Test and profile data	Starting competence level	Teacher confirms profile
Integrated module work	Lesson plan, case, lab analysis	Design and practical-methodological ability	Teacher gives feedback
AI consultation	Prompt history and suggestions	Ability to improve draft work	AI moderator controls safety
Portfolio formation	Collected products and reflections	Diagnostic-reflective growth	Expert reviews quality
Competence map update	Scores by components	Growth dynamics	Teacher confirms level
Final diagnostics	Test, task, portfolio evidence	Final competence level	Teacher/expert conclusion

The third result is the competence map. The map visualizes progress across components: cognitive-integrative, lesson-design, practical-methodological, digital-methodological, communicative, and diagnostic-reflective. Each component is connected with concrete evidence. For example, lesson-design competence is supported by a lesson plan and rubric; digital-methodological competence is supported by a virtual laboratory analysis; diagnostic-reflective competence is supported by a test item, portfolio note, and self-assessment.
The fourth result is an adaptive recommendation mechanism. If the competence map shows a weak component, the platform recommends additional resources, tasks, examples, or consultations. For instance, low performance in diagnostic-reflective competence leads to additional tasks on assessment rubrics and PISA-type item construction. Low performance in digital-methodological competence leads to additional virtual laboratory tasks and analysis examples.

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Discussion

The proposed technology can increase the transparency of teacher preparation because every professional product is connected with a competence component. Instead of relying only on final examinations, the platform collects evidence during the learning process. This makes it possible to see how a student's methodological thinking develops from a simple lesson plan to a more complex integrated module or portfolio product.

The AI component adds value when it supports individualization. A teacher educator cannot always provide immediate feedback to every student on every draft. AI can provide preliminary suggestions, identify missing elements, ask guiding questions, and recommend resources. Nevertheless, the teacher remains responsible for final assessment, interpretation, and pedagogical decision-making. This human-in-the-loop model is essential for reliability and ethics.

Another important implication is the possibility of research-based monitoring. The platform can export data on test results, task completion, portfolio quality, AI-use frequency, and teacher confirmation. These data can be used in future experimental studies to compare control and experimental groups and to calculate growth dynamics, effectiveness coefficients, Student's t-test, or chi-square criteria where appropriate.

The limitation of the present article is that it describes a technology model rather than reporting final experimental statistics. Therefore, the next research stage should implement the technology in real groups of future physics and astronomy teachers and evaluate its effectiveness through initial and final diagnostics.

Conclusion

AI-supported digital-didactic technology can play an important role in developing methodological competence of future physics and astronomy teachers. In the MethodEdu.uz platform, electronic modules, virtual laboratories, diagnostic tests, interactive assignments, AI assistance, portfolios, competence maps, and adaptive recommendations are integrated into one learning trajectory. Such a trajectory helps students learn, act, receive feedback, reflect, and improve their methodological products.

The central principle of the proposed technology is responsible human-centered AI use. AI can help generate ideas, ask questions, analyze drafts, and provide recommendations, but final pedagogical assessment must be confirmed by the

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teacher or expert. When implemented in this way, MethodEdu.uz can become an evidence-based environment for individualized, reflective, and statistically measurable development of future teachers' methodological competence.

References

1. Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial Intelligence in Education: Promises and Implications for Teaching and Learning. Center for Curriculum Redesign.
2. Mayer, R. E. (2009). Multimedia Learning. Cambridge University Press.
3. Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108(6), 1017-1054.
4. Redecker, C. (2017). European Framework for the Digital Competence of Educators: DigCompEdu. Publications Office of the European Union.
5. Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15(2), 4-14.
6. UNESCO. (2023). Guidance for Generative AI in Education and Research. UNESCO.
7. Wiggins, G. (1998). Educative Assessment: Designing Assessments to Inform and Improve Student Performance. Jossey-Bass.
8. Chirchik State Pedagogical University. (2026). MethodEdu.uz adaptive digital learning platform: Technical specification with AI module. Internal project document.