ABSTRACT

of the dissertation on the topic "Development of prospective computer science teachers' readiness to apply visualization technologies in teaching secondary school students" for the degree of Doctor of Philosophy (PhD) in the educational programme 8D01507 – "Computer science"

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Research topic: "Development of prospective computer science teachers' readiness to apply visualization technologies in teaching secondary school students"

Research aim: to theoretically substantiate, develop and experimentally verify the effectiveness of a methodology for developing prospective computer science teachers' readiness to apply information visualization technologies in the educational process of secondary school based on the pedagogical concept of micro-learning.

Research objectives

1. To study the psychological and pedagogical characteristics of the visual information perception by students in grades 5–9 and to theoretically substantiate the visualization technologies' didactic potential in teaching school computer science at the secondary school.
2. To determine the essence and structure of a prospective computer science teachers' readiness to apply visualization technologies and to develop a criterion-based diagnostic framework for determining the levels of its development.
3. To substantiate the didactic capabilities of micro-learning technology and to develop a structural and logical model for developing and diagnosing the prospective computer science teachers' readiness to apply visualization technologies.
4. To determine the content of training prospective computer science teachers to apply technologies for visualizing educational material based on the "question tree of knowledge".
5. To develop software and methodological support for training prospective computer science teachers in a digital micro-learning environment.
6. To pilot and experimentally verify the effectiveness of the developed methodology in the process of prospective computer science teachers' professional training.

Research methods. To address the stated objectives and test the hypothesis, a set of complementary methods was used:

- *theoretical*: analysis of scientific and methodological, psychological and pedagogical, technical literature on the research topic and regulatory documents; study and generalization of pedagogical experience; modeling of the learning process;
- *empirical*: study of students' work products (visual didactic materials), pedagogical observation, testing, questionnaire, comparative analysis of learning outcomes, and pedagogical experiment;
- *methods of mathematical statistics*: processing of experimental data to confirm the statistical significance of the obtained results.

Main provisions submitted for defence

1. Theoretical and methodological substantiation of the application of visualization technologies in the school computer science course (grades 5–9).

The didactic potential of visualization technologies in teaching computer science to students in grades 5–9 is determined by the psychological and pedagogical characteristics of the visual information perception among adolescents' learners (the transition from visual-figurative to abstract-logical thinking and the predominance of clip-based perception) and consists in intensifying the learning process and increasing the level of students' acquisition of abstract algorithmic and theoretical concepts.

2. The essence, component structure and criterion-based diagnostic framework of a prospective computer science teachers' readiness to apply visualization technologies. A prospective computer science teachers' readiness to apply visualization technologies in teaching secondary school is a complex personal and professional quality comprising motivational, cognitive, activity-based and methodological components, the development of which is determined by learners' age-related characteristics.

3. The structural and logical model of readiness development, constructed on the basis of micro-learning technology, ensures the phased acquisition of visualization tools and methods through a system of interconnected micro-modules and reflects target, content, procedural and outcome-related links, taking into account the dynamic updating of digital tools.

4. The selection and structuring of the training content prospective computer science teachers based on the "question tree of knowledge" ensures the logically substantiated segmentation of educational material into micro-modules, develops students' holistic understanding of the visualization didactic potential, and takes into account the psychological and pedagogical characteristics of the visual information perception among secondary school.

5. The methodology for developing a prospective computer science teachers' readiness to apply visualization technologies in teaching secondary school, implemented in a digital micro-learning environment that includes the developed software and methodological complex, ensures students' systematic, practice-oriented acquisition of tools and methods for visualizing educational information and develops their skills in applying these tools in teaching students in grades 5–9.

6. Results of the experimental testing of the methodology's effectiveness. The effectiveness of the developed methodology for training prospective computer science teachers is confirmed by the positive dynamics of the development indicators all readiness components in the experimental group compared with the control group, as well as by the statistical significance of the obtained results according to Pearson's χ^2 test, which confirms the validity of the research hypothesis.

Scientific novelty of the research

– the essence and structure of a prospective computer science teachers' readiness to apply visualization technologies in teaching secondary school have been defined and theoretically substantiated, taking into account age-related features of the visual information' perception;

– a structural and logical model of readiness development has been developed, based on the step-by-step mastery of visualization technologies through a system of interrelated micro-modules;

– the content of training prospective computer science teachers' has been determined on the basis of the "question tree of knowledge", which ensures the segmentation of educational material into micro-modules and helps students develop a holistic understanding of the visualizations' didactic potential at the secondary school;

– software and methodological support has been developed in a digital micro-learning environment for work in grades 5–9;

– a methodology for developing a prospective computer science teachers' readiness to apply visualization technologies in teaching secondary school has been developed and experimentally verified.

Justification of the novelty and importance of the results obtained:

1. For the first time, the essence of a prospective computer science teachers' readiness to apply visualization technologies has been defined and its four-component structure (motivational, cognitive, activity-based and methodological components) taking into account age-related features and patterns of visual information perception among adolescents has been theoretically substantiated.

2. A structural and logical model for developing a prospective computer science teachers' readiness to apply visualization technologies has been developed and scientifically substantiated; it is built on the systems integration and activity-based approaches with micro-learning technology and ensures the phased acquisition of visual tools (from the basic-instrumental to the project-methodological level) through a system of interconnected micro-modules.

3. The content of training a prospective computer science teacher has been scientifically substantiated and developed on the basis of the frame-graph constructor "question tree of knowledge", used for the logical and semantic structuring of educational material into micro-modules and for ensuring semantic coherence between subject knowledge in computer science and methodological techniques for its visualization.

4. Comprehensive software and methodological support has been created that operates in a digital micro-learning environment and contains a structured library of visual didactic materials (interactive diagrams, dynamic models of algorithms, concept maps, and training simulators) designed for the computer science course in grades 5–9.

5. A two-level methodology for developing the readiness of prospective computer science teachers to apply visualization technologies has been developed and experimentally verified; it combines quasi-professional design of a visual learning environment at university (first level) and its adaptation to the educational process of sasecondary school (second level).

Alignment with Scientific Development Priorities and Government Programmes:

The dissertation research was conducted in line with the priority areas of the state policy of the Republic of Kazakhstan in the fields of education and digitalization. It aligns with the Concept for the Development of Higher Education

and Science in the Republic of Kazakhstan for 2023–2029 (Resolution No. 248 of the Government of the Republic of Kazakhstan dated March 28, 2023) with regard to improving the quality of teacher training and developing teachers' digital competencies. It also corresponds to the Concept for the Development of Preschool, Secondary, Technical and Vocational Education in the Republic of Kazakhstan for 2023–2029 (Resolution No. 249 of the Government of the Republic of Kazakhstan dated March 28, 2023) in terms of updating the content and methods of school education through the use of digital educational resources.

Description of the doctoral candidate's contribution to the preparation of each publication (the contribution of the dissertation author is shown as a percentage of the total volume of the text):

1. Bakytbekova, Z., (2026). Navigating the digital divide: An in-depth exploration of ICT devices, knowledge, belief, usage, and attitude in educational settings. Contemporary Educational Technology, 18(2). https://doi.org/10.30935/cedtech (Bakytbekova, Z. – 70%, co-authored with Rice M. F., Esgin E., Kamalova G., Shekerbekova Sh. – 30%).

2. Цифрлық құзыреттілік информатика мұғалімінің кәсіби дағдыларының бірі ретінде // Bulletin of Abai KazNPU, Series "Physical and Mathematical Sciences". – 2023. – No. 4(84). – P. 321–331. https://doi.org/10.51889/2959-5894.2023.84.4.032 (Bakytbekova, Z. – 70%, co-authored with Shekerbekova Sh.T. – 30%).

3. Визуализация технологияларын оқыту болашақ информатика мұғалімдерінің цифрлық құзыреттілігін дамыту факторы ретінде// Bulletin of Abai KazNPU, Series "Physical and Mathematical Sciences". – 2024. – No. 2(86). – P. 253–263. https://doi.org/10.51889/2959-5894.2024.86.2.023 (Bakytbekova, Z. – 70%, co-authored with Kamalova G.B. – 30%).

4. Диагностическая модель готовности учителя информатики к использованию технологий визуализации // Bulletin of Abai KazNPU, Series "Physical and Mathematical Sciences". – 2024. – No. 4(88). – P. 218–232. https://doi.org/10.51889/2959-5894.2024.88.4.022 (Bakytbekova, Z. – 80%, co-authored with Pak N.I. – 20%).

5. Обучение будущих учителей современным технологиям визуализации: перспективы и вызовы // Proceedings of the International Scientific and Practical Conference "Integration of Artificial Intelligence into the Educational Process in the Era of Global Digitalization: Strategies, Innovations and Cybersecurity Challenges", dedicated to the 70th anniversary of Academician of the National Academy of Engineering of the Republic of Kazakhstan, Doctor of Technical Sciences, Professor B.S. Akhmetov. – Almaty: Abai Kazakh National Pedagogical University, 2024. – P. 192–196. ISBN 978-601-7175-57-3 (Bakytbekova, Z. – 70%, co-authored with Kamalova G.B. –30%).