ABSTRACT

of the dissertation entitled "Development and implementation of an intelligent model for assessing university students' programming knowledge" submitted in fulfillment of the requirements for the degree of Doctor of Philosophy (PhD) in the specialty 6D011100 – Informatics by Asset Zhaxylykov

Research topic: Development and implementation of an intelligent model for assessing university students' programming knowledge.

Research aim: to provide a scientific rationale for, develop, and implement an intelligent model that ensures objective and comprehensive assessment of university students' programming knowledge.

Research objectives:

- to analyze the current state of assessing students' programming knowledge and identify the specific features of assessment in the context of using intelligent learning tools;
- to determine the principles of intelligent assessment of students' programming knowledge and refine the assessment criteria;
- to develop an intelligent model for assessing students' programming knowledge;
- to propose methods for organizing assessment based on the intelligent model for assessing students' programming knowledge;
- to experimentally validate the intelligent model for assessing students' programming knowledge and evaluate its effectiveness.

Research methods: theoretical analysis and synthesis of philosophical, psychological-pedagogical and scientific-methodological literature related to the research problem, regulatory documents, and national and international studies in the field of programming education and knowledge assessment; observation, surveys, testing, analysis of the results of students' programming activities and their task-completion processes; pedagogical experiment, quantitative and qualitative analysis of experimental results, and methods of mathematical statistics.

Main provisions submitted for defense:

- intelligent assessment of students' programming knowledge is aimed at comprehensive criterion-based evaluation that takes into account data characterizing students' programming activities and is not limited solely to the outcome of a programming task;
- the principles and assessment criteria of intelligent programming knowledge assessment constitute the theoretical basis for the integrated evaluation of both the outcomes of students' programming activities and their task-completion processes;
- the intelligent model for assessing students' programming knowledge is based on the interrelationship among the pedagogical-goal component, criterion-based assessment component, level-based task component, intelligent analytical component, and result-interpretative component, and ensures comprehensive evaluation of both

the outcomes of students' programming activities and their task-completion processes;

- methods for organizing assessment based on the intelligent model ensure objective and comprehensive assessment of programming knowledge through the collection, analysis, and evaluation of heterogeneous data derived from students' programming activities and the pedagogical interpretation of the results.

Main research results:

- the specific features of assessing students' programming knowledge in the context of using intelligent learning tools were identified;
- the principles of intelligent assessment of students' programming knowledge were determined, and assessment criteria enabling comprehensive evaluation of the outcomes of students' programming activities and their task-completion processes were refined;
- an intelligent model for assessing students' programming knowledge was developed based on the interrelationship among the pedagogical-goal component, criterion-based assessment component, level-based task component, intelligent analytical component, and result-interpretative component;
- methods for organizing the assessment of students' programming knowledge based on the developed intelligent model were determined.

Novelty and significance of the results obtained:

- the specific features of assessing students' programming knowledge in the context of using intelligent learning tools were identified, and the need to consider not only the outcomes of students' programming activities but also their task-completion processes, errors made and actions taken to correct them, algorithmic explanations, and data on their interactions with intelligent tools was substantiated. The identified features provide a theoretical basis for determining the principles of intelligent programming knowledge assessment, assessment criteria, and the structure of the intelligent model;
- the principles of intelligent assessment of students' programming knowledge were determined, and assessment criteria enabling comprehensive and integrated evaluation of both the outcomes of students' programming activities and their task-completion processes were refined. The proposed principles, assessment criteria, and indicators provide a methodological basis for the objective, criterion-based, and interpretable assessment of students' programming knowledge using multicomponent data;
- an intelligent model for assessing students' programming knowledge was developed based on the interrelationship among the pedagogical-goal component, criterion-based assessment component, level-based task component, intelligent analytical component, and result-interpretative component. The model enables the pedagogical purpose of assessment, assessment criteria and indicators, level-based tasks, intelligent analysis of assessment data, and pedagogical interpretation of the results to be integrated into a unified system. It also enables the results of intelligent analysis to be incorporated into the teacher's pedagogical decision-making process;
- methods for organizing assessment based on the intelligent model for assessing students' programming knowledge were determined, and the content and sequence of their application were established. The proposed methods enable the intelligent model to be implemented in university programming education, facilitate the collection and

analysis of data characterizing both the outcomes of students' programming activities and their task-completion processes, and allow the obtained results to be used by teachers for pedagogical decision-making.

Alignment with the areas of scientific development or state programs: the Concept for the Development of Higher Education and Science in the Republic of Kazakhstan for 2023–2029, approved by Resolution No. 248 of the Government of the Republic of Kazakhstan dated March 28, 2023; the Concept for the Development of Artificial Intelligence in the Republic of Kazakhstan for 2024–2029, approved by Resolution No. 592 of the Government of the Republic of Kazakhstan dated July 24, 2024; the Law of the Republic of Kazakhstan "On Artificial Intelligence" dated November 17, 2025, No. 230-VIII.

Doctoral student's contribution to the preparation of each publication (the dissertation author's contribution is given as a percentage of the total volume of the publication):

1. Improving Programming Learning Outcomes for AI-Driven Students using a Digital Assessment Environment // International Journal of Engineering Education. – 2026. – Vol. 42, No. 4. – P. 1116–1130. – URL: https://www.ijee.ie/contents/c420426.html. Percentile – 44 % (Zhaxylykov A. – 70%, co-authors: Nurbekova Zh., Sagimbayeva A., Aimicheva G., Nazyrova A., Artykbayev N. – 30%).

2. Comparative Analysis of GenAI Models in Problem Solving on the LeetCode Platform // 2025 10th International Conference on Computer Science and Engineering (UBMK). – Istanbul, Türkiye: IEEE, 2025. – P. 131–136. (Zhaxylykov A. – 70%, co-authors: Nurbekova Zh., Sagimbayeva A., Shekerbekova Sh. – 30%). – DOI: 10.1109/UBMK67458.2025.11206938.

3. Intelligent System for Analyzing The Career Achievements of IT Specialists: Development and Implementation of an AI-Based Software Solution // 2025 10th International Conference on Computer Science and Engineering (UBMK). – Istanbul, Türkiye: IEEE, 2025. – P. 1270–1274. (Zhaxylykov A. – 60%, co-authors: Nurbekova Zh., Naimanova D., Tkach G., Dautova A., Rakhimbayev A. – 40%), DOI: 10.1109/UBMK67458.2025.11206957.

4. The Need to Implement Knowledge Assessment Based on a Computer-Based Multilevel Information Model // Bulletin of Abai KazNPU. Series of Physical and Mathematical Sciences. – 2015. – №3(51). – P. 259–263. (Zhaxylykov A. – 70%, co-authors: Sagimbayeva A. – 30%).

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9. Problems of developing criteria and descriptors for assessing students' knowledge of programming // Bulletin of Kh.Dosmukhamedov Atyrau University. – Atyrau, – 2025. №77(2). – P. 131-140. – DOI: 10.47649/vau.25.v77.i2.11. (Zhaxylykov A. – 60%, co-authors: Sagimbayeva A., Zhamkeeva A., Kemelbek M. – 40%).

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19. Criteria for Assessing Knowledge in a Programming Course // Mathematical modeling and information technologies in education and science: materials of X International scientific and methodical conference dedicated to the 40th anniversary of school informatics and the 80th anniversary of Professor Y.Y. Bidaibekov. – Almaty, 2025. – P. 914–918. ISBN 978-601-311-284-8. (Zhaxylykov A. – 60%, co-authors: Shekerbekova Sh., Sagimbayeva A. – 40%).

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