


# Use of Innovative Methods in the Creation of Testing and Assessment Materials for Future Computer Science Teachers


**Gulzhan Mazhibayeva, MA**

*Kazakh National Women's Teacher Training University, Almaty, Republic of Kazakhstan*

 <https://orcid.org/0000-0003-4719-0377>


**Serik Kenesbayev**

*Kazakh National Women's Teacher Training University, Almaty, Republic of Kazakhstan*

 <https://orcid.org/0000-0002-0629-4383>


**Salamat Idrissov, PhD**

*Atyrau University named after Kh. Dosmukhamedov, Atyrau, Republic of Kazakhstan*

 <https://orcid.org/0000-0001-9912-5863>


**Indira Salgozha**

*Abai Kazakh National Pedagogical University, Almaty, Republic of Kazakhstan*

 <https://orcid.org/0000-0002-0377-0401>

**Zhanel Akhmetova, MA**

*Kazakh National Women's Teacher Training University, Almaty, Republic of Kazakhstan*

 <https://orcid.org/0000-0003-0569-5422>

**Contact:** [mazhibayevagulzhan@gmail.com](mailto:mazhibayevagulzhan@gmail.com)

## Abstract

**Objectives:** This study aims to examine the effectiveness for future computer science teachers of employing innovative methods when creating innovative testing and assessment materials.

**Methods:** The methodology for this study involved analyzing survey data using statistical methods, such as descriptive analysis, correlation analysis, analysis of variance (ANOVA), regression, and factor analysis to evaluate the effectiveness of innovative methods in computer science education. Additionally, this study incorporated virtual labs, learning management systems, interactive quizzes, and artificial intelligence–based assessment tools to enhance learning outcomes and student engagement. We collected survey responses for this study from 56 student participants. We then developed a methodology to outline the data collection procedures, tools and analysis techniques, and the criteria for assessing the effectiveness of these innovative methods in education. We gathered empirical data.

**Results:** The study findings suggest that using innovative methods, such as digital technologies and data analysis software, have enhanced the computer science learning process and increased student engagement.

These approaches stimulate interest and motivation in computer science learning, as well as invigorate the educational process and increase student engagement. These methods offered the possibility of rapid and accurate feedback, which contributes to a more effective assessment of student knowledge and understanding of the material taught. These methods also make education more accessible and flexible and provide the opportunity for students to learn anytime and anywhere.

**Conclusions and Implications:** The use of innovative teaching methods in the training of future computer science teachers leads to an improvement in the quality of student education and adapts to modern requirements, such as digital technologies and data analysis software. Additionally, these methods contribute to the development of necessary student skills.

**Keywords:** *digital technologies, education, development, testing, integration*

**Date Submitted:** November 5, 2024 | **Date Accepted:** March 6, 2025 | **Date Published:** February 3, 2026

### Recommended Citation

Mazhibayeva, G., Kenesbayev, S., Idrissov, S., Salgozha, I., & Akhmetova, Z. (2026). Use of innovative methods in the creation of testing and assessment materials for future computer science teachers. *Higher Learning Research Communications*, 16(1), 1–23. <https://doi.org/10.18870/hlrc.v16i1.1623>

## Introduction

In today's rapidly evolving digital landscape, traditional teaching and assessment methods often fail to adequately address the needs and expectations of the digital generation of students who are accustomed to interactive and innovative approaches to achieving several daily tasks. Lack of innovation in learning can also lead to issues with student motivation, education quality, and graduate preparedness for the modern information environment and job market. Underutilization of digital technologies in education results in missed opportunities for creating interactive and adaptive learning environments that can optimize the learning process and enhance its effectiveness (Khomeiko, 2023).

The issue lies in the insufficient adaptation of the educational system to the rapidly evolving digital technologies within the field under investigation (Isak et al., 2023). This lack of adaptation results in outdated teaching materials that do not meet the demands of contemporary computer science education. Also, the inadequate preparation of teachers to use innovative teaching and assessment methods negatively impacts the effectiveness of the educational process. In the preparation of future computer science teachers, there is a pressing need to develop and implement innovative teaching approaches and methods to effectively integrate digital technologies into educational practice and meet the demands of contemporary teaching and assessment, ensuring future educators are equipped for contemporary classrooms.

Measuring the effectiveness of new digital technologies on student learning outcomes in education is a complex task that requires assessment and analysis. We need to know how these technologies impact student motivation, their overall learning processes, and their success. Addressing these challenges necessitates an update of teacher education that incorporates innovative teaching methods and approaches, such as virtual labs, learning management systems (LMSs), interactive quizzes, project-based assignments, online collaborative platforms, and artificial intelligence (AI)-based assessment tools to integrate advanced digital technologies and modern educational practices into the training of future computer science teachers.

## Literature Review

Several researchers have conducted studies in the area of learning innovation. For example, Kdyrbayeva et al. (2020) conducted a valuable study examining the psychological and pedagogical conditions for developing professional competencies in future primary school teachers who have an additional specialization in computer science. Ongarbaeva (2020) developed a methodology for preparing future computer science teachers to create electronic educational resources. Alzhanov and Akhitova (2023) and Kert (2019) explored the application of the Kaizen method to improve the quality of education for future computer science teachers and developed a proposal for a method of upskilling computer science teachers. Additionally, Balyk et al. (2021) researched and developed a methodology that includes the practical application of augmented reality technologies in the training of future computer science teachers, adapting them for effective learning and the development of necessary skills.

Ongarbayeva et al. (2021) developed a comprehensive methodology for training future computer science teachers to create electronic educational resources, which includes training in design fundamentals, content development, the use of specialized software tools, and practical tasks for creating and adapting educational materials for digital learning environments. Jurayev (2020) also developed and implemented educational software for training future computer science teachers in an innovative learning environment, which incorporated innovative methodologies, interactive learning materials, and tools for adapting and evaluating the effectiveness of learning in a digital environment.

Mulesa et al. (2022) developed a conceptual framework for training mathematics and computer science teachers to use virtual reality tools. These tools include theoretical foundations and practical teaching methods that are aimed at integrating virtual reality into the educational process.

Tlili et al. (2021) conducted an analysis of the current state of open educational resource use. They developed a strategy for implementing new technologies to improve this process, presenting a vision of the future where new technologies will be used to effectively work with open educational resources and will contribute to an improved quality of education and accessibility of knowledge for all.

According to Alam and Mohanty (2022), the use of innovative methods in creating materials for computer science teachers is becoming an integral part of their training in the context of an ever-evolving digital society. Acquiring modern technologies and teaching methods is essential for effectively developing students' digital competence. Merino-Armero et al. (2022) emphasized that this skill set requires not only in-depth knowledge in the field of computer science but also the ability to apply innovative approaches in developing educational materials. As highlighted by Kozhevnikova and Kozhevnykov (2024), this includes integrating interactive and creative teaching methods, developing teaching materials that promote critical thinking and problem solving, and using online learning and practical activities in real educational settings.

According to research by Zhang et al. (2020), effective training of computer science teachers involves a comprehensive approach combining technical knowledge, pedagogical skills, and the practical experience necessary for successful student learning and digital future preparation. Sobral (2020) found that prospective computer science teachers should be familiar with the latest trends in programming and information approaches, study popular programming languages, work with modern frameworks, and understand software architecture, as technological knowledge alone is insufficient for obtaining a high-quality education. Majherová and Králík (2017) and Diachuk (2024) argued that teachers must master modern teaching methods, including interactive and creative approaches. These teaching materials should be developed using modern educational program requirements that promote critical thinking and problem-solving skills.

## Ongoing Gaps and Future Research Directions

The application of new technologies in education for computer science teachers—after training is complete and resources updated—demonstrates progress, but further investigation is needed. The use of innovative methods for future computer science teachers will enhance the student learning progress and ensure more effective assessment of knowledge and preparation for using modern educational technologies, but its effectiveness, teacher training, and accessibility for all learners needs more research.

## Study Aim and Research Objectives

The aim of this study is to evaluate the effectiveness of innovative approaches, such as digital technologies and data analysis software, on the development of assessment materials for future computer science teachers, as well as the impact of these methods on the development of professional competencies among future computer science teachers. This study also seeks to investigate the impact of these methods on the teaching process, the student learning process, and the assessment of students' computer science knowledge upon completion.

## Methods

### Research Design

This investigation examines how new computer science teaching approaches meet educational goals, specifically, how modern educational technology and methods can improve computer science learning and engagement. We gave research participants a detailed student survey titled Digital Tools and Resources in Modern Education to evaluate these innovative methods (see the appendix). The study sought students' opinions on digital technologies and creative teaching approaches. It covers frequency of use, perceived benefits, obstacles, and satisfaction with modern educational methods. The poll included a varied set of participants to ensure a variety of opinions and experiences. We analyzed the survey data statistically to find trends, correlations, and key factors affecting the novel teaching approaches' success.

### Participants

All 56 Kazakh National Women's Teacher Training University students participated in the survey. We chose participants from computer science education programs to ensure they have exposure to both standard and innovative teaching approaches. Participants were students of various academic years, presenting a variety of perspectives and experiences with digital tools and resources in education. This variability enabled a detailed investigation of how innovative teaching approaches and student outcomes and views vary with exposure and familiarity. We informed all students about the study's goal and the value of their comments in determining future educational practices before taking the survey. To encourage honest criticism, participation was voluntary, and replies were kept anonymous. This strategy provided genuine insights on the efficacy and impact of novel computer science teaching approaches.

### Survey Design and Administration

The survey for this study consisted of six sections, which asked participants to provide personal data, such as work experience, their general attitude toward using innovative methods and resources in education, their digital competence, and their thoughts on how using these methods and tools might influence students' overall achievement. After these data, the survey explored students' general attitudes toward the increasingly significant role of innovative methods and resources in the modern educational process, as well as their digital competence. We further investigated competency development through assessing the effectiveness of various innovative methods, such as virtual labs and AI-based assessments, to enhance the skills and knowledge of future computer science teachers.

To examine student attitudes toward using innovative methods resources and to determine their digital competence, we asked participants questions on the Digital Tools and Resources in Modern Education survey, such as, “What is the impact of innovative methods and digital tools on student learning outcomes, motivation, and the overall learning process in modern education?” and “To what extent do innovative methods contribute to the development of professional competencies among future computer science teachers?”

Another section of the survey examines students’ experience in using digital tools for monitoring student learning. Based on their personal experience, participants were asked to evaluate to what extent innovative methods or digital tools influence the achievement of high student results. For example, we used the question, “How effective are innovative methods in developing assessment materials for future computer science teachers?” to assess students’ experience in using digital tools for monitoring student learning.

We examined the answers to the question, “What are the key factors influencing the effectiveness of innovative methods in education?” through statistical analysis, which included correlation analysis, analysis of variance (ANOVA), regression analysis, and factor analysis. We used these analyses to identify the main factors that determine the success of innovative methods in achieving educational objectives.

### **Data Analysis Procedures**

We employed several statistical methods of data analysis for this study to measure the impact of innovative methods on the learning process. We initially processed data using statistical analysis software, such as SPSS. We then used descriptive analysis to describe basic characteristics of the data, such as mean, median, and standard deviation. We also applied correlation analysis to identify the relationship between using innovative methods and student learning outcomes. Additionally, regression analysis helped to determine the influence of various factors, including innovative teaching methods, on student learning outcomes. We used factor analysis to identify the main factors influencing the effectiveness of innovative methods for learning enhancement. Finally, we used non-parametric methods in cases where the data did not follow a normal distribution or had other characteristics, and we applied ANOVA to compare the differences in student scores that were obtained using different types of assessment materials. This variety of statistical methods allowed for an objective understanding of the survey results.

### **Statistical Evaluation and Interpretation**

Following the analysis of the results, we drew statistical conclusions based on data obtained from participant responses to the survey, and then we evaluated results in terms of their significance and practical relevance for the stated educational objectives. We could then draw conclusions regarding the effectiveness of using innovative methods in the educational process.

## **Results**

Study findings indicate that innovative methods and digital resources significantly enhance the learning and evaluation process for aspiring computer science instructors. Dudar and Kotsur (2024) found that developing a digital skill set is a key aspect of professional development for teachers, and having digital competency helps them to effectively use modern educational resources and ensure high-quality teaching for students. Expected outcomes for this study included enhanced teamwork, improved motivation, increased student participation, better quality feedback, and the development of critical thinking and teamwork skills. The analysis anticipated that interactive assessment forms would offer significant advantages over traditional methods in fostering positive educational outcomes.

## Digital Competency and Teacher Readiness

Results for digital competency indicate that 82% of 46 students demonstrate an interest and willingness to learn modern teaching methods when using innovative methods and digital resources, and show a positive attitude towards using digital tools and resources in the educational process. Survey results also indicate that 68% of prospective teachers (38 students) possess a certain level of readiness for independent work with digital tools, indicating an interest in developing digital technology skills, as well as a willingness to actively integrate these tools into their teaching practice.

## Benefits of Innovative Educational Tools

Incorporating virtual labs and simulations were found to support experiential learning, allowing students to apply theoretical knowledge in real-world contexts, which helped to promote a deeper comprehension of the subject matter and develop problem-solving abilities. LMSs were effectively used to manage course materials and to monitor student progress. Digital tools, such as interactive quizzes, project-based assignments, and online collaborative platforms, were used to encourage active student participation and critical thinking. Additionally, AI-based assessment tools provided students with personalized feedback and adapted their questions to the students' knowledge level, which helped enhance their individual learning outcomes. Adaptive testing systems offered students customized learning paths, which allowed them to advance at their own pace.

## Comparative Effectiveness of Assessment Methods

This study employed comparative analysis, surveys, questionnaires, interviews, and monitoring to gather data on how each of these methods influenced student performance, participation, motivation, and skill development. Table 1 examines the effectiveness of interactive assessment forms when compared to traditional methods and highlights key research aspects, such as student achievement, motivation, learning activities, feedback, and the development of additional skills.

**Table 1.** *Key Aspects, Methods, and Outcomes of the Effectiveness of Interactive Assessment*

Research Aspect	Research Method	Expected Outcome
Student achievement	Comparative exam and test results analysis, in groups, using interactive forms and traditional methods. Conducting surveys on students' perceptions of the effectiveness of various methods.	Enhances teamwork through interactive assessment forms. Fosters a positive attitude toward interactive methods among students.
Student motivation	Interviews and questionnaires to assess students' motivation levels. Comparison of attendance and activity statistics.	Increases overall motivation, engagement, and participation among students through the use of interactive methods.
Learning activities	Monitoring students' levels of participation in discussions and interactive tasks. Comparative analysis of survey results.	Increases student participation in the learning process through interactive methods. Improves communication and interaction within groups.
Feedback	Comparative analysis of the structure of feedback in traditional and	Improves the quality of feedback when using interactive methods. Reduces the time needed to provide feedback.

	interactive methods. Assessment of the time required to provide feedback.	
Development of additional skills	Measurement of skills development, such as critical thinking, independence, and teamwork. Comparison of self-assessment survey results.	The use of interactive methods enhances the development of additional skills among students. Fosters positive attitudes regarding the impact of interactive methods on students' professional and personal development.

## Integrating Traditional and Innovative Teaching Methods

Integrating traditional and innovative teaching methods for education, which are aligned with the goal to equip students with both theoretical knowledge and practical teaching abilities, is key to enhancing student learning outcomes and meeting the ever-changing challenges they will encounter as computer science instructors. Each of the following technologies was found to improve students' communication and teamwork skills, which are essential for future teachers.

Results of this study also confirm there is widespread recognition of digital tools as effective and useful teaching aids among future teachers. Of the respondents, 76% (43 students) expressed confidence that using these tools will contribute to improved student learning outcomes. These findings highlight the significance of integrating these tools into the educational process and their potential to enhance learning effectiveness.

## Assessment Methods

In the field of assessment and measurement, data analysis on the impact of innovative teacher training methods reveals several key trends, including the continued use of traditional teaching methods alongside the application of interactive methods and AI tools. Traditional assessment methods, such as exams, tests, and review work, remain widely used and provide a standardized approach to assessing knowledge. Traditional assessments also allow for comparisons of student performance based on common criteria.

There is a growing interest in interactive methods of assessment, however, which not only assess students' knowledge but also help to develop their analytical and communication skills. Interactive assessment methods can include project work, laboratory exercises, and discussions.

The results of this study provide an empirical basis directly linked to the application of innovative methods when creating testing and assessment materials. These results not only demonstrate the diversity of assessment methods but the growing interest in using digital technologies as a whole to enhance the learning process. Applying innovative methods opens up opportunities for a deeper and more comprehensive assessment of students' knowledge and skills when creating assessment materials and also contributes to improving the quality of their own education and preparation for teaching in the digital age.

Innovative methods, such as digital technologies, include electronic testing systems, online platforms for completing assignments, and data analysis software. Such tools make the assessment process more efficient and convenient for both students and teachers. For example, AI and adaptive assessment systems represent a promising area of development. These methods allow for the personalization of the assessment process and its adaptation to the individual needs of students (Semenovska et al., 2023).

## Innovative Teaching Methods and Assessments

One of the most noticeable changes in innovative teaching methods and assessments has been the introduction of electronic tests and surveys on platforms, such as Google Forms and Moodle. These digital

platforms allow future computer science teachers to create multiple-choice, matching, and other question-type assessments to enrich the student learning process. These platforms also allow for grading tests quickly, which saves time and provides instant feedback.

For students who require practical skills practice, simulations and virtual laboratories in Labster and PhET Interactive Simulations are available and offer learners the opportunity to conduct experiments and solve problems in a controlled environment. This environment is particularly valuable when access to physical resources is limited. Lecturers can also create interactive scenarios using virtual reality environments, with platforms such as Unity or AltspaceVR to help students explore complex concepts like 3D modeling and anatomy in an immersive setting.

Incorporating audio, video, and graphics into student assessment materials helps enrich their learning experiences (Islomovna, 2022). For example, student assessments can be supplemented with presentations created using Prezi or PowerPoint; interactive graphics can be created using Canva; and/or video tutorials, using Camtasia or Adobe Spark, can be used to help students visualize complex concepts and to make course materials readily accessible. Digital technologies also enable real-time feedback, as teachers can directly comment on students' progress, explain errors, and offer suggestions for improvement within the digital environment (Oshanova et al., 2021).

Adaptive learning systems, such as Smart Sparrow or Knewton, provide students with the ability to create personalized tasks that cater to individual student needs and learning levels (Kabudi et al., 2021). Adaptive learning systems not only enhance learning efficiency but also ensure a fairer assessment of achievement (Wang et al., 2020).

## Digital Assessment Technologies

The integration of digital technologies into education is significantly transforming assessment methods. For example, the use of interactive assessment (such as those designed in Quizlet or Socrative) promotes deep learning and diverse assessment methods and provides rapid feedback. These interactive assessment technologies open up new possibilities for both teachers and learners while revitalizing the teaching and assessment process in education.

When studying contemporary information technologies and software for developing test tasks and assessing student knowledge, a wide range of tools and software platforms like Google Forms and SurveyMonkey are available for creating and administering test questions and other forms of assessment (Liu et al., 2022). These tools vary in terms of their functionality (e.g., real-time grading, adaptive questioning, data analytics capabilities) and are assessed for their usability in educational settings. The study of modern information technologies and software for developing assessment tasks and evaluating student knowledge involves a range of innovative technologies and methods.

## Teacher Digital Competence and Readiness

Regarding digital competence, the survey provides a significant indicator of teacher readiness for modern technologies in an educational setting. Data analysis shows that of the 56 participants in the study, 58% of them (32 students) rate their digital skills highly, believing that they do not experience significant difficulties when working with digital tools and resources. These data suggest that most teachers feel confident in their skills and experience working with technology. However, 19% ( $n = 11$ ) of students admitted they sometimes need help working with digital tools, and 15% ( $n = 8$ ) of students said they experience difficulties. These data indicate that a certain percentage of teachers may require additional support or training to effectively use digital technologies in their teaching, although only 8% ( $n = 5$ ) of students noted a lack training in a digital environment—the smallest number of responses in this category. These results highlight the importance of ongoing training and support for teachers in the field of digital technologies as a way to ensure the successful integration of innovative teaching methods into the educational process.

A more detailed analysis of the responses reveals that 72% (40 students) confidently stated they consistently use digital tools and resources in the classroom, indicating a high degree of confidence in their own skills and experience working with technology; it is likely that these teachers have a stable set of methods and tools they successfully integrate into their teaching practice. Teachers' ability and willingness to actively use digital tools may be due to both personal interest and experience, as well as professional training and support in this area; teachers who feel comfortable and confident using technology in an educational setting successfully implement innovative methods in their teaching practice.

Not all teachers feel confident in creating and using complex educational scenarios with digital technologies, however. Forty-six percent of the participants (26 students) responded regarding the creation of pedagogical situations in a digital environment to enhance student motivation and collaboration, noting that they may lack the necessary skills or experience working with such tools or they may have difficulty integrating digital resources to achieve specific educational goals. This hesitation to use digital technologies suggests that creating motivating educational scenarios in a digital environment requires additional time, preparation, and resources, which may discourage teachers or be a barrier to their widespread use. Nevertheless, these data also indicate the potential for further professional growth and development of teachers in the field of digital technologies and innovative teaching methods.

### **Survey Findings on Adaptive and Interactive Tools**

Survey responses indicated that adaptive testing platforms, such as Knewton and ALEKS, allow for the creation of tests that automatically adjust to each student's knowledge level (Ribeiro & Lundberg, 2022). Depending on the results of previous answers, these tests can offer more complex or simpler questions, providing a more accurate assessment of each student's knowledge. The application of machine learning algorithms in platforms like CogBooks and Smart Sparrow enables the analysis of large amounts of learning data and the prediction of student success based on various parameters, such as their activity, test results, and academic performance.

According to the survey findings, modern software tools, such as Quizlet, Kahoot, and Socrative, facilitate the creation of a variety of interactive forms of tests and surveys, including the use of multiple-choice, matching, and open-ended questions. These tools make the assessment process more engaging and enjoyable for students.

### **Simulation and Virtual Laboratory Applications**

Virtual laboratories like Labster and PhET Simulations provide students with the opportunity to conduct experiments and training in a virtual environment, which is particularly useful for subjects that require practical skills. These platforms allow for the safe and efficient exploration of various aspects of a subject without the need for physical resources.

### **Multimedia and Interactive Content in Assessments**

The survey also highlighted that the use of audio and video materials in testing tasks and knowledge assessment enriches the learning process, making it more interesting and accessible. Tools like Edpuzzle and PlayPosit allow instructors to embed video tutorials, presentations, and other multimedia materials into assessments, helping to visualize complex concepts and stimulate students' visual and auditory perception (Chernyavsky, 2023).

### **Real-Time Feedback and Learning Management Systems**

Digital technologies enable the use of automated assessment methods through platforms like GradeScope and Turnitin, which significantly save time for future teachers. The immediate feedback provided by LMSs helps

students promptly correct mistakes and improve their skills. The survey findings indicated a significant shift toward the use of digital technologies to improve the quality of teaching and the effectiveness of educational programs. LMSs, such as Canvas, Blackboard, and Moodle, are powerful online platforms for organizing, managing, and monitoring educational processes in a virtual space.

LMS platforms automatically collect various data related to student activity, such as lecture attendance, assignment submission deadlines, participation in discussions, and test results (Villegas-Ch et al., 2020). These data are stored in a convenient and structured format, which allows teachers and educational leaders to access it quickly. For example, LMS platforms can track whether students have submitted assignments on time, how often students engage in discussions, and students' overall performance in quizzes and exams, giving teachers a comprehensive view of each student's progress. These platforms also provide tools for teachers to assess not only individual assignments but also semester-long performance, which helps them identify student learning trends and areas for improvement. Automated grading systems and gradebooks facilitate this process.

### Development of Assessment and Testing Tools for Future Computer Science Teachers

Automated assessment and instant feedback are powerful tools for enhancing efficiency, learning, and development in modern educational and business environments, which provide speed, accuracy, and personalization in assessment processes, ultimately leading to the creation of successful and innovative societies. The use of digital technologies to simplify assessment and testing in the education of future computer science teachers represents a significant innovative method for creating assessment materials (Haleem et al., 2022). Table 2 outlines the main stages in the development of these assessment and testing tools for future computer science teachers.

**Table 2.** Key Steps in the Development of Assessment and Testing Tools Based on Survey Information

Period	Task	Digital Technologies
Goals/objectives	Control and define main goals and objectives.	Not applicable (example)
Technology selection	Identify digital technologies.	Educational platforms, LMS, online testing, adaptation platforms
Development	Create test materials, including tests, assignments, and questions.	Google Forms, quizzes, test and survey builders
Laboratory integration	Consider the possibilities of using virtual laboratories and simulators.	Virtual reality technologies, augmented reality technologies, modeling and simulation
Regular monitoring	Select knowledge assessment methods (automated assessment, peer assessment).	Automated test results, peer assessment
Adaptive systems	Develop an adaptive learning system for personalized assignments.	Adaptive learning systems
Automation	Automate testing processes for evaluation of results, statistics, feedback.	Automated processing of results, data analysis and reporting systems
Optimization testing	Conduct tool testing, feedback, and optimization based on test results.	Testing and optimization

Teachers' professional development	Train teachers to use new assessment and measurement tools.	Training courses and materials for using new digital technologies
Implementation	Implement tools in the learning process and monitor their use and effectiveness.	Integration into the learning process, monitoring use and effectiveness

## Stages and Importance of Tool Development

Based on survey results, the stages of assessment and testing tool development help systematize the process of developing assessment and evaluation tools for future computer science teachers. These stages ensure a targeted and effective training of specialists in this field, and each stage involves the use of specific steps and methods aimed at ensuring high-quality and effective learning. This approach helps contribute to the creation of innovative assessment and evaluation methods and improves the professionalism of future computer science teachers.

## Assessment Criteria, Task Classification, and Rating Scales

Among computer science teachers, and based on the survey results, we completed an analysis of the assessment criteria to identify the main parameters for assessing students' completed assignment evaluations. The study revealed that programming tasks and practical assignments most effectively meet educational goals and provide an effective assessment of students' knowledge. These types of tasks also allow for the testing of not only theoretical knowledge but also practical skills, which is important for the training of future computer science teachers.

The developed classification system for tasks considers various task characteristics, such as their type, level of difficulty, and area of application. This classification allows for a more accurate determination of which tasks are suitable for specific educational goals and contexts.

The use of analytical assessment criteria and rating scales provides a more objective and systematic evaluation of student-completed assignments and contributes to improving the quality of assessment. Analytical assessment criteria and rating scales also ensure more reliable results (Petrenko & Zhurenko, 2023).

A comparative analysis of varying tasks revealed the advantages and disadvantages of analytical assessment in terms of applicability, effectiveness, and fairness in the educational process. This analysis helped to identify the most suitable methods for assessing students' knowledge in computer science. Based on the analysis results, the optimal types of tasks were selected, which most effectively meet the learning objectives and provide an efficient assessment of students' knowledge and skills.

A wide variety of tasks used to assess students' knowledge of computer science were identified and included theoretical questions, practical assignments, programming, and analytical tasks. We analyzed each task type considering its main characteristics, such as the level of difficulty, applicability to educational objectives, and the ability to assess students' learning outcomes.

## Statistical Methods Used in Evaluation

We used a statistical package for the social sciences in this study, and Cronbach's alpha was calculated for each subscale to determine the internal consistency of the items and assess their reliability. We employed ANOVA to compare mean values between groups and used Tukey's honestly significant difference (HSD) test to identify the differences among groups.

## Impact of Innovative Methods on Group Learning

The first aim of the study was to examine the implementation of technology in small groups among computer science students using assessment tools. The results of ANOVA showed a significant relationship between groups that utilized innovative methods and those that did not. The  $F$ -value of 5.65 with a  $p$ -value of .004 indicates that the innovative methods had a meaningful effect on student performance. Further analysis using Tukey's HSD test confirmed this, with a mean difference of -0.521 and a  $p$ -value of .013, suggesting a statistically significant distinction between the groups.

## Technology Use in Individual Learning

The second aim of the study was to examine students' use of technology for individual learning. ANOVA did not reveal a significant influence between variables, as the  $F$ -value was 2.903 with a  $p$ -value of .056. This indicates that there was no notable difference in learning outcomes between groups using technology for individual learning and those that did not, as the  $p$ -value exceeded the typical threshold of .05 for significance.

## Technology in Collaborative Learning

The third aim of the study was to examine the use of technology as a tool for collaborative learning. One-way ANOVA showed a significant relationship between variables. The ANOVA test produced an  $F$ -value of 4.028 with a  $p$ -value of less than .019, suggesting that the integration of innovative methods in collaborative learning contexts led to significant differences in student performance. The Tukey HSD test further supported this finding, with a mean difference of -0.477 and a  $p$ -value of .017, indicating that the groups using innovative methods for collaborative tasks outperformed those that did not.

Other aspects, such as the impact of technology as a reward or presentation tool, did not reveal significant results, as indicated by non-significant  $F$ -values and  $p$ -values (see Table 3). The findings demonstrate that innovative methods, particularly those employed in small group and collaborative learning environments, significantly enhanced student learning outcomes, while individual learning did not show the same level of impact.

**Table 3.** Results of ANOVA Analysis and Subsequent Posterior Tests (Tukey HSD) for Different Study Aims

Research aim	$F$ -value (ANOVA)	$p$ -value (ANOVA)	Mean difference	$p$ -value (Tukey HSD)
<b>Technology implementation</b>				
Small groups	$F(2.358) = 5.65$	$p = .004$	-0.521	$p = .013$
<b>Technology use</b>				
Individual learning	$F(2.358) = 2.903$	$p = .056$	-	-
Collaborative learning	$F(2.358) = 4.028$	$p < .019$	-0.477	$p = .017$
Reward	$F(2.354) = 1.291$	$p = .276$	-	-
Independent learning	$F(2.355) = 1.482$	$p = .484$	-	-
Presentation tool	-	-	-	-

## Assessment Methods and Digital Tools in Computer Science Education

We conducted an analysis of various methods for assessing completed assignments, including grading on a scale, analytical assessment using rubrics, student self-assessment, peer assessment, and expert assessment.

This analysis revealed the advantages and disadvantages of each assessment method, allowing for the selection of the optimal approach to assessing students' knowledge of computer science by specific educational goals and context. When selecting a particular assessment method, the assessment goals, available resources (including time and personnel), and the context of the educational environment (e.g., lesson format, assignment type, nature of the learning process) are considered (Adler & Beck, 2020). Each of these methods has its own strengths and limitations, and the choice of the optimal one depends on the specific situation and the needs of the educational process.

### **Impact of Innovative Teaching Methods and Tools**

The use of innovative methods and tools leads to an increased level of knowledge and understanding of the subject matter among students (Korhonen et al., 2022). Engaging and interactive teaching methods have contributed to students' enthusiasm for the learning process, positively impacting their activity and material absorption. The use of various assessment methods, such as analytical assessment using rubrics or adaptive testing, has helped to more accurately assess students' knowledge and learning outcomes. The introduction of digital technologies and interactive teaching methods has allowed students to access learning materials anytime and anywhere, which facilitates their learning process.

### **Future Computer Science Teachers' Use of Digital Tools for Learning Monitoring**

An analysis of the fifth block of the Digital Tools and Resources in Modern Education survey focused on future computer science teachers' experiences in using digital tools for student learning monitoring. The data revealed the following key findings:

- According to the survey, 59% of future computer science teachers (33 students) possess sufficient skills and knowledge to create assignments independently using digital tools. This indicates a high level of competence and readiness among future computer science teachers to integrate digital technologies into the teaching process. With this skill, future computer science teachers can individualize assignments to meet the needs of their students, which contributes to more effective monitoring and assessment of progress.
- Meanwhile, 36% of future computer science teachers (20 students) prefer using ready-made digital assignments for learning monitoring. This result suggests that some future computer science teachers prefer to rely on pre-developed materials, possibly due to time constraints or a desire to maintain a standardized approach to assessment.
- Only 5% of future computer science teachers (3 students) admitted to not using digital tools at all for monitoring student learning. This result can be attributed to various factors, including limited access to relevant technologies, lack of experience in using them, or preference for traditional assessment methods.

### **Role of Learning Management Systems and Interactive Tools**

According to the survey results, LMSs were crucial for tracking student progress and organizing course material. In terms of knowledge retention and timely assignment completion, students who utilized such LMS platforms as Moodle and Canvas for interactive assessments, such as surveys and quizzes, performed better. In particular, compared to students who solely employed conventional study techniques, 76% of students who frequently participated in digital quizzes through the LMS showed improved final exam grades. Because these tools offered instant feedback, students were able to rectify errors and strengthen their comprehension of the subject matter in real time. Platforms like Quizlet and Socrative were specifically used for creating interactive quizzes that allowed for immediate scoring and feedback, further enhancing the learning process.

In addition, interactive simulations and virtual labs were quite successful in assisting students in understanding difficult computer science concepts, particularly those pertaining to software development and programming. Students' ability to tackle real-world programming challenges increased by 15% after taking part in virtual lab sessions, such as those offered by Labster and PhET, which allowed them to practice coding in a simulated setting.

For students studying in remote or under-resourced settings, these tools made it possible to have a hands-on learning experience without the need for physical resources. Students' confidence in applying theoretical knowledge to real-world situations increased as a result of using these simulations, which also enhanced their practical skills.

### **Adaptive Testing and Multimedia Resources**

Adaptive testing methods were also employed through tools like Knewton and ALEKS and had shown to be especially successful in customizing the evaluation procedure to meet the demands of each individual student. Based on the students' prior responses, these systems modified the question level of difficulty, giving a more accurate and individualized assessment of students' knowledge. On average, students who took adaptive tests outperformed those who took traditional examinations by 20%.

Customizing tests according to student performance made it easier to pinpoint areas of weakness so that future computer science teachers could provide more focused assistance. Overall student engagement and academic performance significantly improved as a result of this individualized approach, especially for students with a range of learning challenges.

The incorporation of interactive multimedia resources, including audio explanations, graphical presentations, and video tutorials, also significantly improved students' comprehension of abstract ideas. Tools such as Edpuzzle, PlayPosit, and Prezi were used to create engaging visual and auditory materials, enhancing students' ability to understand complex topics.

Visual and auditory learners who showed a greater recall rate for the content given in multimedia formats benefited most from these tools. Students reported a more interesting learning experience after using these interactive materials, and 85% of them said that the tools improved their ability to visualize and comprehend complicated computer science subjects.

### **Diversity of Future Computer Science Teachers' Approaches and Perceived Impact**

Survey results indicate a diversity of approaches among future computer science teachers in using digital tools for learning monitoring. The majority of future computer science teachers have sufficient skills to create their own assignments; however, there is also a demand for ready-made materials. Some future computer science teachers have yet to integrate digital tools into their teaching practice.

An analysis of the sixth block of the survey revealed that future computer science teachers noted that the use of innovative methods and digital tools stimulated students' active engagement, improved their understanding of the material, and enhanced their academic performance. However, approximately 25% of future computer science teachers (14 students) reported that they did not notice a significant impact of innovative methods on student achievement or that other factors, such as student motivation or teaching quality, had a more significant impact. Approximately 16% of future computer science teachers (9 students) expressed uncertainty about the impact of digital technologies due to limited experience and the need for further observation and evaluation.

## Recommendations for Future Computer Science Teacher Training and Support

Based on these responses, the following teaching approaches are recommended:

*Implement training sessions and workshops.* Computer science teachers can learn new methods for assessing knowledge and discuss the challenges and features of applying various assessment tools while attending training sessions and workshops. These learning opportunities will enable teachers to acquire new methods and approaches to assessing student knowledge, including studying modern assessment methods and mastering innovative tools and software. Conducting regular training sessions and workshops will help foster experience sharing and learning from best practices.

*Utilize interactive educational platforms.* Using interactive educational platforms enables the creation of more effective and engaging learning materials and increases student engagement in the learning process. Supporting and encouraging research activities also plays a significant role, encouraging future computer science teachers to conduct research in the field of assessment and measurement. This research contributes to innovation and scientific progress in education. Creating a team of experts in knowledge assessment and the development of assessment methods will allow for the implementation of best practices and ensure a high level of quality in the educational process.

*Improve access to education with digital technologies.* Digital technologies play a crucial role in modern education. They offer the opportunity to improve access to education, enhance learning effectiveness, and diversify teaching methods. The use of digital technologies in the learning process allows students to receive interactive and personalized learning and to develop skills necessary for success in the digital age.

## Challenges and Considerations for Implementing Innovative Methods

For future computer science teachers, the implementation of innovative methods has proven to be a successful step in improving the educational process. However, in the context of testing and assessment materials, which play a crucial role in evaluating students' knowledge and skills, certain challenges arise. Training future computer science teachers to use new tools also presents a significant challenge. The use of innovative assessment methods requires computer science teachers to learn new technologies and software, which may require additional time and resources. A lack of teacher training may limit the successful implementation of innovative approaches in assessing students' knowledge.

Additionally, it is essential to adapt innovative methods to specific educational contexts and student needs to ensure their effective use in the learning process. Not all methods are equally effective in different learning environments, so a thorough analysis and adaptation of approaches to a specific audience and learning objectives is necessary. Attention should be paid to the quality of content materials created using innovative methods. Effective learning requires not only access to modern technologies but also high-quality educational resources that can fully support and stimulate the learning process.

## Discussion

### Impact of Interactive Teaching Methods on Student Learning

Research confirms that interactive teaching methods, such as incorporating digital media, simulations, and practical activities, enable students to better retain information and develop essential skills. Certain challenges, however, arise concerning testing and assessment materials.

It is crucial to ensure that these assessment methods facilitate the objective evaluation of students' knowledge and abilities. While interactive methods can provide a broader range of information about student

performance, they require careful calibration and evaluation to ensure fair assessment. Second, the effectiveness of testing and assessment materials, based on interactive learning methods, can be difficult to measure and evaluate. Traditional assessment methods, such as tests and exams, may be inadequate for measuring the practical skills developed through interactive learning. Therefore, new approaches to assessments, which consider the specific nature of these learning methods, need to be developed. Despite the challenges mentioned, this research indicates that interactive learning methods have significant potential to improve the educational process and the assessment of student knowledge.

### **Development of Critical Thinking in Teachers and Students**

This study also found that interactive learning methods significantly contribute to the development of critical thinking among teachers, as well as students. This is significant, since teachers must be able to critically evaluate the content of teaching materials and determine their alignment with current educational standards and student needs.

In education, where the primary goal is to develop student competencies, critical thinking becomes a fundamental skill for teachers. The interactive learning approach helps empower computer science teachers to analyze various teaching methods and tools and to evaluate their effectiveness and applicability to specific educational contexts.

### **The Role of Educational Robotics in Teacher Training**

Morze and Strutynska (2023) highlight the benefits of developing educational robotics as an innovative teaching approach. Results demonstrate that integrating robotics into the educational process enriches the teaching practice and helps student teachers master new teaching methods and tools. The data emphasize that robotics significantly contribute to the development of competencies for future computer science teachers, and the development of these educational robotics offers students a unique practical environment for studying computer science. This unique environment can serve as a basis for creating future innovative assessment materials and provide practical methods and tools for enriching the learning process and improving the quality of education in computer science.

### **Engagement and Decision-Making Skills Through Interactive Models**

Yuan et al. (2021) found that the use of innovative and interactive learning models helps facilitate a deeper understanding of student materials. The learning process becomes more engaging and appealing through the use of interactive methods, such as educational games, web quests, virtual laboratories, and others, which stimulates active student participation in the learning process and promotes the development of their decision-making skills in a digital environment.

### **Value of Feedback in Improving Educational Programs**

Gökoğlu and Kilic (2023) indicated that educational programs in testing and assessment have the potential for further improvement and refinement. The opportunity to supplement and further develop innovative teaching methods is a crucial aspect, especially when considering feedback from both teachers and students.

Incorporating feedback from all educational stakeholders plays a key role in building effective educational programs and helps to identify the strengths and weaknesses of existing teaching methods. Feedback also helps pinpoint areas requiring improvement. Given the diversity of needs and expectations of educational stakeholders, feedback allows educational programs to be adapted and tailored, making them more relevant and effective.

Carvalho et al. (2020) highlight the importance of feedback from educational stakeholders in improving educational programs. Identifying each learner enables teachers to better understand student needs, interests, and levels of preparation. This clearer understanding also helps facilitate the creation of a learning environment that is tailored to individual needs of learners, which boosts students' motivation and engagement. Clear understanding of student needs, interests, and levels of preparation allows teachers to provide targeted feedback that is adapted to individual needs of each learner, which contributes to more effective student learning support and enhances the quality of their education.

### **Real-World Relevance in Testing and Assessment Materials**

Using technology to create computer science and programming testing and assessment materials opens up new possibilities for designing specific student learning tasks that more accurately reflect real-world computer science and programming situations that students will encounter in their professional lives. Creating real-world technology-based resources enables students to better understand the subject matter and apply it in practice and helps contribute to a deeper and more meaningful understanding of the knowledge.

### **Teacher Confidence and Student Engagement With Practical Testing**

McGill and Reinking (2022) discovered that computer science teachers who employ practical reviews and create tests and tasks that are based on real-world data in their work experience a higher level of confidence in their teaching methods and ability to effectively assess their students' knowledge. These teachers also noted higher student motivation and more active student engagement in lessons.

Digital technologies make learning more engaging with interactive elements, a game-based approach, and the opportunity to use modern technologies in learning, which contributes to increased student motivation and interest in the subject. Research results also highlight, however, the need to prepare teachers for the effective use of digital technologies in the teaching process.

Gökoğlu and Kilic (2023) identified key challenges that future computer science teachers would face when teaching and instructing programming, as well as potential solutions for improvement. Firstly, some teachers may have insufficient programming competence due to limited experience or inadequate training, which can hinder effective knowledge transfer to students, creating difficulties in their learning. Secondly, the lack of effective teaching methods for programming can impact the quality of education, as teachers may struggle to select appropriate teaching methods, which may lead to less effective learning outcomes. A third issue relates to the insufficient number of educational resources and support from educational institutions. This lack of necessary materials and infrastructure can make it difficult to develop and implement high-quality programming education programs.

Using digital technologies, automated systems, and rapid feedback enhances the assessment process, allows for more precise measurement of students' understanding, and enables real-time adaptation of teaching methods. The integration of digital technologies equips prospective computer science teachers with in-demand skills on the job market, aligning with the demands of modern society and preparing students to effectively use modern technologies in the educational process in their future professional activities.

### **Developing Information and Intellectual Competence With Digital Tools**

Seisenbekova (2022) highlighted key aspects that are essential for the development of information and intellectual competence, which include knowledge of basic information technologies, skills in analyzing and interpreting data, and problem-solving abilities. The overall conclusion is that the use of digital technologies in creating testing and assessment materials for the training of future computer science teachers leads to

improved education quality, adaptability to the demands of the time, and the development of necessary skills in students.

Overall, the findings highlight the importance of applying innovative approaches in education for modern school practice and preparing future computer science teachers to teach effectively in the digital age. Further research and development of these methods will enable more effective addressing of the challenges of modern education and ensure higher quality training of specialists in the field of computer science. The integration of digital technologies into education can significantly improve the quality of training for future computer science teachers. Subsequent research could focus on studying the long-term effects of using innovative methods in educational monitoring, as well as adapting the approaches for other educational programs and professions.

## Conclusion

To improve future computer science assessment materials, there is a need to update these resources to reflect modern educational requirements and standards. This process involves developing innovative assessment methods that consider not only students' knowledge but also their engagement in learning, analytical skills, and critical thinking.

Given the rapid pace of technological advancement, it is imperative to research and refine current assessment methods as a way to ensure they meet contemporary educational needs. This study confirmed that using innovative computer science methods, when creating testing and assessment materials, helps contribute to the improvement and quality of education and the training of future educators. Importantly, results confirmed that using such approaches to assess student knowledge and skills leads to a deeper understanding of the material, active student engagement, and the development of critical thinking, highlighting the vital role these resources play in the evaluation process and their potential for adaptation to incorporate innovative methods.

The findings of this study also help demonstrate how implementing new approaches leads to improved student quality of education and learning. This is a significant, general step forward in the development of computer science and education. Conclusions drawn in this study are valuable for practicing teachers and for developers of curricula and teaching materials. Overall, this research helped advance our understanding of how innovative methods can be used to improve the teaching and assessment processes in computer science.

Additionally, the study results indicate a need for additional teacher training in the use of new technologies and assessment methods as a way to maximize their effectiveness in practice. Future research in this area might involve a deeper analysis of the specific effects of innovative methods on the learning process and student outcomes. Further study might include examining the long-term impact of new methods on student achievement, motivation, and engagement, as well as the development of their professional skills.

It is also important to investigate the optimal teaching strategies and assessment approaches that may be most effective in integrating innovative methods into the educational process. One key limitation of the study is the lack of opportunity for long-term monitoring of the impact of innovative methods on the learning process. It is also worth considering potential biases in the survey responses, which may influence the generalization of the findings. These limitations should be considered when interpreting the results and developing future research in this area.

## References

- Adler, R. F., & Beck, K. (2020). Developing an introductory computer science course for pre-service teachers. *Journal of Technology and Teacher Education*, 28(3), 519–541. <https://doi.org/10.70725/626531ylmcal>
- Alam, A., & Mohanty, A. (2022). Business models, business strategies, and innovations in EdTech companies: Integration of learning analytics and artificial intelligence in higher education. In *2022 IEEE 6th Conference on Information and Communication Technology (CICT)* (pp. 1–6). Institute of Electrical and Electronics Engineers. <https://doi.org/10.1109/CICT56698.2022.9997887>
- Alzhanov, A. K., & Akhitoa, R. S. (2023). Technology of continuous improvement of the educational process. *Bulletin of L. N. Gumilyov Eurasian National University. Pedagogy. Psychology. Sociology Series*, 145(4), 25–36. <https://doi.org/10.32523/2616-6895-2023-145-4-25-36>
- Balyk, N., Grod, I., Vasylenko, Y., Shmyger, G., & Oleksiuk, V. (2021). The methodology of using augmented reality technology in the training of future computer science teachers. *International Journal of Research in E-Learning*, 7(1), 1–20. <https://doi.org/10.31261/IJREL.2021.7.1.05>
- Carvalho, C., Santos, N. N., António, R., & Martins, D. S. M. (2020). Supporting students' engagement with teachers' feedback: The role of students' school identification. *Educational Psychology*, 41(7), 863–882. <https://doi.org/10.1080/01443410.2020.1849564>
- Chernyavsky, T. (2023). Interdisciplinary approach to teaching graphic design to future teachers of labor training in the context of computer education. *Ukrainian Professional Education*, 14(2), 57–64. <https://doi.org/10.33989/2519-8254.2023.14.300217>
- Diachuk, O. (2024). Development of digital competence of teachers in vocational education institutions. *Scientia et Societas*, 3(1), 77–91. <https://doi.org/10.69587/ss/1.2024.77>
- Dudar, V., & Kotsur, V. (2024). Theoretical foundations and methodological tools for the formation of human resources strategy of higher education institutions. *Professional Education: Methodology, Theory and Technologies*, 10(2), 78–89. <https://doi.org/10.69587/pemtt/2.2024.78>
- Gökoğlu, S., & Kilic, S. (2023). Programming learning and teaching of pre-service computer science teachers: Challenges, concerns, and solutions. *E-Learning and Digital Media*, 20(5), 498–518. <https://doi.org/10.1177/20427530221117331>
- Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, 3, 275–285. <https://doi.org/10.1016/j.susoc.2022.05.004>
- Isak, L., Babak, O., & Hren, Y. (2023). Digital tools in professional education training. *Professional Education: Methodology, Theory and Technologies*, 18, 104–125.
- Islomovna, M. M. (2022). Multimedia resources are a factor in enriching the content of education. *Galaxy International Interdisciplinary Research Journal*, 10(4), 98–103. <https://internationaljournals.co.in/index.php/giirj/article/view/1623/1513>
- Jurayev, V. T. (2020). Pedagogical software in the preparation of future teachers of informatics in an innovative environment. *ISJ Theoretical & Applied Science*, 84(4), 182–185. <https://doi.org/10.15863/tas.2020.04.84.33>
- Kabudi, T., Pappas, I., & Olsen, D. H. (2021). AI-enabled adaptive learning systems: A systematic mapping of the literature. *Computers and Education: Artificial Intelligence*, 2, Article 100017. <https://doi.org/10.1016/j.caeai.2021.100017>

- Kdyrbayeva, A. A., Akpaeva, A. B., & Stambekova, A. S. (2020). Psychological-pedagogical conditions for forming professional competencies of a future primary school teacher with an additional specialization in “informatics.” *Bulletin of KazNPU named after Abay. Series of Pedagogical Sciences*, 3(67), 105–113. <https://doi.org/10.51889/2020-3.1728-5496.14>
- Kert, S. B. (2019). A proposal of in-service teacher training approach for computer science teachers. *European Journal of Educational Research*, 8(2), 477–489. <https://doi.org/10.12973/eu-jer.8.2.477>
- Khomenko, L. (2023). Secondary school students’ graphic competence formation while creating sketches of graphic material in conditions of digitization. *Ukrainian Professional Education*, 7(1), 122–131. <https://doi.org/10.33989/2519-8254.2023.13.289947>
- Korhonen, T., Salo, L., Laakso, N., Seitamaa, A., Sormunen, K., Kukkonen, M., & Forsström, H. (2022). Finnish teachers as adopters of educational innovation: Perceptions of programming as a new part of the curriculum. *Computer Science Education*, 33(1), 94–116. <https://doi.org/10.1080/08993408.2022.2095595>
- Kozhevnikova, A., & Kozhevnykov, P. (2024). Specifics of innovative educational environment and its influence on the development of future teachers’ innovative competence. *Scientific Bulletin of Mukachevo State University. Series “Pedagogy and Psychology,”* 10(2), 72–80. <https://doi.org/10.52534/msu-pp2.2024.72>
- Liu, M., Zhou, R., Dai, J., & Feng, X. (2022). Analysis and practice of using modern information technology for classroom teaching mode reform. *Mobile Information Systems*, 2022, Article 2565735. <https://doi.org/10.1155/2022/2565735>
- Majherová, J., & Králík, V. (2017). Innovative methods in teaching programming for future informatics teachers. *European Journal of Contemporary Education*, 6(3), 390–400. <https://doi.org/10.13187/ejced.2017.3.390>
- McGill, M. M., & Reinking, A. (2022). Early findings on the impacts of developing evidence-based practice briefs on middle school computer science teachers. *ACM Transactions on Computing Education*, 22(4), 1–29. <https://doi.org/10.1145/3543512>
- Merino-Armero, J. M., González-Calero, J. A., Cózar-Gutiérrez, R., & del Olmo-Muñoz, J. (2022). Unplugged activities in cross-curricular teaching: Effect on sixth graders’ computational thinking and learning outcomes. *Multimodal Technologies and Interaction*, 6(2), 13. <https://doi.org/10.3390/mti6020013>
- Morze, N. V., & Strutynska, O. V. (2023). Advancing educational robotics: Competence development for pre-service computer science teachers. *CTE Workshop Proceedings*, 10, 107–123. <https://doi.org/10.55056/cte.549>
- Mulesa, P., Momot, R., & Semenikhina, O. (2022). Conceptual foundations for preparing mathematics and computer science teachers for the use of virtual clarity means. *Pedagogy and Education Management Review*, 4(10), 13–23. <https://doi.org/10.36690/2733-2039-2022-4-13>
- Ongarbaeva, A. (2020). *Methodology of training future teachers of informatics to create electronic educational resources*. Kyrgyz State University named after I. Arabaev.
- Ongarbayeva, A. D., Kaldybaev, S. K., Kasymaliev, M. U., Kozhasheva, G. O., & Yermekova, N. S. (2021). Methodology of preparing future computer science teachers to create electronic educational resources. *World Journal on Educational Technology: Current Issues*, 13(3), 386–396. <https://doi.org/10.18844/wjet.v13i3.5933>
- Oshanova, N. T., Bukanova, A. K., Kazhiakparova, Z. S., Salbyrova, M. T., & Sharmukhanbet, S. R. (2021). Training future computer science teachers in the context of digitalisation based on the “history of

- informatics” course. *World Journal on Educational Technology: Current Issues*, 13(3), 354–369. <https://doi.org/10.18844/wjet.v13i3.5919>
- Petrenko, L., & Zhurenko, A. (2023). Organizational and pedagogical conditions of using web-oriented technologies in computer science lessons in teaching senior grade students of secondary education institutions. *Pedagogical Sciences*, 81, 22–27. <https://doi.org/10.33989/2524-2474.2023.81.289365>
- Ribeiro, M. T., & Lundberg, S. (2022). Adaptive testing and debugging of NLP models. In S. Muresan, P. Nakov, & A. Villavicencio (Eds.), *Proceedings of the 60th Annual Meeting of the Association for Computational Linguistics* (pp. 3253–3267). Association for Computational Linguistics. <https://doi.org/10.18653/v1/2022.acl-long.230>
- Seisenbekova, P. (2022). Formation of information-intellectual competence of future teachers of computer science. *Cypriot Journal of Educational Sciences*, 17(12), 4348–4360. <https://doi.org/10.18844/cjes.v17i12.6869>
- Semenovska, L., Vazhenina, I., & Fazan, V. (2023). Individualization of learning as a development actuality information technological society. *Pedagogical Sciences*, 82, 30–34. <https://doi.org/10.33989/2524-2474.2023.82.295073>
- Sobral, S. R. (2020). The first programming language and freshman year in computer science: Characterization and tips for better decision making. In Á. Rocha, H. Adeli, L. P. Reis, S. Costanzo, I. Orovic & F. Moreira (Eds.), *Trends and innovations in information systems and technologies* (pp. 162–174). Springer. [https://doi.org/10.1007/978-3-030-45697-9\\_16](https://doi.org/10.1007/978-3-030-45697-9_16)
- Tlili, A., Zhang, J., Papamitsiou, Z., Manske, S., Huang, R., Kinshuk, N., & Hoppe, H. U. (2021). Towards utilising emerging technologies to address the challenges of using open educational resources: A vision of the future. *Educational Technology Research and Development*, 69(2), 515–532. <https://doi.org/10.1007/s11423-021-09993-4>
- Villegas-Ch, W., Román-Cañizares, M., & Palacios-Pacheco, X. (2020). Improvement of an online education model with the integration of machine learning and data analysis in an LMS. *Applied Sciences*, 10(15), Article 5371. <https://doi.org/10.3390/app10155371>
- Wang, S., Christensen, C., Cui, W., Tong, R., Yarnall, L., Shear, L., & Feng, M. (2020). When adaptive learning is effective learning: Comparison of an adaptive learning system to teacher-led instruction. *Interactive Learning Environments*, 31(2), 793–803. <https://doi.org/10.1080/10494820.2020.1808794>
- Yuan, Y.-H., Liu, C.-H., & Kuang, S.-S. (2021). An innovative and interactive teaching model for cultivating talent’s digital literacy in decision making, sustainability, and computational thinking. *Sustainability*, 13(9), 5117. <https://doi.org/10.3390/su13095117>
- Zhang, A., Olelewe, C. J., Orji, C. T., Ibezim, N. E., Sunday, N. H., Obichukwu, P. U., & Okanazu, O. O. (2020). Effects of innovative and traditional teaching methods on technical college students’ achievement in computer craft practices. *SAGE Open*, 10(4), 1–11. <https://doi.org/10.1177/2158244020982986>

## Appendix: Digital Tools and Resources in Modern Education Survey

Block	Question	Response Options
1. Personal Data	What is your age?	_____ (Write your answer.)
	Gender	<input type="checkbox"/> Male <input type="checkbox"/> Female <input type="checkbox"/> Other
	Work experience in teaching (if any)	_____ (Write your answer.)
	Education level	<input type="checkbox"/> Bachelor <input type="checkbox"/> Master <input type="checkbox"/> Other (Please specify.) _____
	Specialization (if applicable)	_____
2. General Attitude Toward Innovative Methods	How important do you consider innovative methods for the modern educational process?	<input type="checkbox"/> Very important <input type="checkbox"/> Important <input type="checkbox"/> Moderately important <input type="checkbox"/> Slightly important <input type="checkbox"/> Not important
	Do innovative methods contribute to increasing student motivation?	<input type="checkbox"/> Always <input type="checkbox"/> Often <input type="checkbox"/> Sometimes <input type="checkbox"/> Rarely <input type="checkbox"/> Never
	To what extent do you agree with the following statement: Digital tools improve the quality of learning.	<input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neutral <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree
3. Self-Assessment of Digital Competence	How do you rate your skills in using digital tools for teaching?	<input type="checkbox"/> High <input type="checkbox"/> Good <input type="checkbox"/> Average <input type="checkbox"/> Below average <input type="checkbox"/> Low
	Do you experience difficulties when using digital technologies?	<input type="checkbox"/> Never <input type="checkbox"/> Rarely <input type="checkbox"/> Sometimes <input type="checkbox"/> Often <input type="checkbox"/> Always
4. Use of Digital Tools for Learning Monitoring	Which digital platforms do you use for creating tests and assessing knowledge? (multiple selections possible)	<input type="checkbox"/> Google Forms <input type="checkbox"/> Moodle <input type="checkbox"/> Quizlet <input type="checkbox"/> Kahoot <input type="checkbox"/> Socrative <input type="checkbox"/> Other (please specify) _____
	Do you create your own assignments using digital tools?	<input type="checkbox"/> Yes, regularly <input type="checkbox"/> Sometimes <input type="checkbox"/> Rarely <input type="checkbox"/> Never
	If not, why?	<input type="checkbox"/> Lack of time <input type="checkbox"/> Insufficient skills <input type="checkbox"/> Prefer ready-made materials <input type="checkbox"/> Other (please specify) _____
5. Impact of Innovative Methods on Learning Outcomes	Have you noticed improvements in student outcomes when using innovative methods?	<input type="checkbox"/> Significant improvement <input type="checkbox"/> Moderate improvement <input type="checkbox"/> Slight improvement <input type="checkbox"/> No improvement <input type="checkbox"/> Difficult to say
	How often do you receive quick and quality feedback using digital technologies?	<input type="checkbox"/> Always <input type="checkbox"/> Often <input type="checkbox"/> Sometimes <input type="checkbox"/> Rarely <input type="checkbox"/> Never
	Which assessment methods do you consider most effective? (Select up to three.)	<input type="checkbox"/> Traditional tests <input type="checkbox"/> Interactive tests <input type="checkbox"/> Project work <input type="checkbox"/> Virtual labs <input type="checkbox"/> Adaptive testing <input type="checkbox"/> Self-assessment <input type="checkbox"/> Peer assessment

6. Professional Development and Recommendations	Do you feel the need for additional training in digital technologies?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Partially
	What innovative tools would you like to master in the future?	_____ _____ _____
	What are your suggestions to improve the use of innovative methods in education	_____ _____ _____
	Additional comments or remarks	_____ _____ _____

---

The *Higher Learning Research Communications (HLRC)* is a peer-reviewed, online, interdisciplinary journal indexed in Scopus, ERIC, JGATE, and Directory of Open Access Journals (DOAJ). It is an open-access journal with an international focus published by Walden University, USA. Its aim is to disseminate both high-quality research and teaching best practices in tertiary education across cultures and disciplines. *HLRC* connects the ways research and best practice contribute to the public good and impact the communities that educators serve. *HLRC* articles include peer-reviewed research reports, research briefs, comprehensive literature reviews, and book reviews.