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Assessment and Evaluation Methods for 21st Century Education: Measuring What Matters

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Abstract: In modern education, not only teaching methods, but also assessment methods play an important role. An adequate assessment system is essential to the development of skills that are

necessary for successful careers of applicants. Therefore, the purpose of the research is the analysis of modern assessment methods in the educational process and their significance for the formation of 21st century skills. The PRISMA approach was used to search for relevant materials. Google Scholar was chosen as the main database for literature search. Works written in English or with English annotations were taken into analysis. 10 criteria for the inclusion of literature were developed, which related to the relevance, practical importance and scientific novelty of the research. Therefore, 40 positions were selected. The study used the coding method for the systematic analysis of textual data. Hence, the results showed that the main approaches to assessment in modern education are summative and formative assessment. Summative assessment summarizes student achievement after the learning process is complete, while formative assessment improves learning outcomes in real time through feedback. Special attention is paid to the active use of digital technologies, such as computer adaptive testing, e-portfolios and platforms for online testing. The conclusions emphasize that innovative assessment should contribute to the development of key skills of the 21st century. The development of digital literacy is especially important, as it allows all participants of the study to actively use technologies and understand them.

Keywords: evaluation, measurement, education, digital technologies, skills.

Introduction

Social life and the professional sphere in today's dynamic world are changing extremely quickly. Under such circumstances, the educational system faced problems and the need for rapid adaptation to innovative demands, needs and challenges. Education in the current 21st century aims not only at the process of providing students with theoretical knowledge and individual practical skills, but also with broad competencies that are necessary for further successful professional realization, development in the conditions of the dominance of the information society and the globalized labour market (Tawalbeh, 2017). Modern authors have determined the effectiveness of combining different assessment methods (Jackson, 2018; Koka et al., 2023). Under the conditions of the constant evolution of information digital technologies, the possibilities of artificial intelligence and innovative methods of obtaining education are developing particularly rapidly, some traditional assessment methods are gradually losing their relevance, remaining less effective against the background of the use of new methods (Divjak et al., 2022; Cañadas, 2021). For this reason, an urgent problem is the need to develop and implement new approaches to the evaluation of the work and knowledge of education seekers, which would become a process that would fully meet modern educational challenges.

Research Problem

The methods of assessing the skills and theoretical knowledge of students of education play a key role during the learning process, because they determine how the success of students' learning can be measured, including determining the effectiveness of using educational programs and the results of their implementation. However, the use of traditional methods, such as tests and standardized examinations, may not take into account a wide range of relevant competencies and skills that are acquired in the learning process, important for functioning within modern society, but thus cannot be successfully assessed during session tests. Therefore, there is a desire to draw attention to the use of alternative methods of assessment activities aimed at a tangible and more accurate comprehensive measurement of the real achievements and potential of higher education applicants. Also, the digitalization of education draws attention to this process, since the active introduction of new technologies in education simultaneously implies their use not only in the learning process, but also during the evaluation and measurement of the knowledge of students.

Research Focus

The proposed study highlights modern assessment methods in higher education environments. Emphasis is placed on those practices and experiences that have the greatest importance within the framework of modern education. The subject for consideration is also various innovative approaches in the field of assessment, in particular - the use of project-based learning, portfolio methods, tools for measuring self-assessment and mutual assessment in the environment of student groups, which not only contribute to the development of critical thinking and creative abilities, but also affect the formation of social skills and the development of emotional intelligence.

Research Aim and Research Questions

The purpose is to analyze effective and recognized assessment strategies that will help to educate competent and adaptive specialists who are able to respond to the challenges of the modern world. Research questions:

1. What methods are used to support the education system of the 21st century?
2. What methods and tools are used in the assessment?
3. What are the educational skills of the 21st century and what is the importance of assessment methods for their development?

Literature Review

Recent studies have highlighted the importance of using different methods of student assessment. These methods should be effective and contribute to optimizing learning for all students, regardless of their level of knowledge, social status or gender. den Boer, Verkoeijen & Heijltjes (2020) described various existing approaches that function in the system of summative and formative assessment in online learning. The researchers also drew attention to the effectiveness of these methods and their impact on student performance. It is important that the researchers were able to compare summative and normative learning. Ahmad (2020) identified the relationship between summative assessment, test scores, and text quality. The author also analyzed cohesion as an unspecified descriptor in the grading scale and analyzed how this aspect affects the overall results of students' assessment. Alexander, Owen & Thames (2020) focused on exploring the main differences and relationships between online formative and summative assessment in vocational education. This paper also analyzes the evaluation of these methods and how they affect learning outcomes and prepare students for future careers. Alfalah (2023) described the factors that influence students' adoption and subsequent use of mobile learning management systems. Importantly, this paper also describes how these technologies affect the learning process and the effectiveness of assessment. A similar issue was also addressed by Alhussain (2017), who analyzed the effectiveness of learning management platforms and their importance in the assessment system. In addition, Arianti et al. (2022) described the development of a scientific e-module based on the SETS approach with a system of formative assessment to improve the critical thinking of students. Barteit et al. (2020) critically reviewed the effectiveness of e-learning in medical education in low- and middle-income countries. This author also described the impact of e-learning on the quality of education. The study by Basnal (2022) identified the importance of assessing 21st century skills, in particular, the author included adaptation, critical thinking, creativity, and communication. Bezanilla et al. (2019) describes various methodologies for developing critical thinking in higher education from the perspective of teachers. This comprehensive study also describes different assessment approaches used to develop these skills. At the same time, Bin Mubayrik (2020) characterized new trends in formative and summative assessment in adult education research. Broadbent et al. (2021) identified the impact of

self-regulated learning on formative and summative assessments in a comparison of online and blended learning. Another important study is Brookhart (2008), which describes the role of portfolio assessment, which is considered as an assessment tool in the 21st century. However, Darabi Bazvand & Rasooli (2022) described students' experiences of using summative assessment techniques in higher education. Therefore, as can be seen from this review, modern authors have focused on the analysis of specific assessment methods, but it is important to take a comprehensive approach to this issue and characterize different assessment techniques and determine their effectiveness.

Materials and Methods

The study used a content analysis of the literature, which involved a rigorous search according to selected criteria and analysis of the literature. Thus, the study is based on the processing of qualitative materials and their interpretation.

Sample and Instruments

The PRISMA approach was used to search for relevant materials. This approach allowed us to include the most relevant results and analyze them. First, the main scientific and metric database was selected for the literature search: Google Scholar. Key words such as: assessment, education, higher education, assessment technologies, methods, formative assessment, summative assessment were entered into the search query of this database. 2345 results were found. After that, the date range was limited to 2014 to 2024¹. A total of 1343 relevant results were found. After that, a preliminary analysis of the titles was carried out and only those papers that dealt with the education system were selected (843). After that, only those papers that were written in English or had an English-language abstract were taken into account. Thus, based on the review of each work, the list of sources was reduced to 651. After that, only those papers were selected that dealt with methods and dimensions of assessment in education (345 results). After that, separate criteria for including literature were developed:

- 1.The study contains up-to-date information on the peculiarities of assessment in modern education
- 2.The study analyzes various assessment techniques and technologies
- 3.The study pays attention to formative assessment
- 4.The study pays attention to summative assessment
- 5.The study describes various digital technologies and features of control implementation
- 6.The study presents the international context of teaching

Thus, based on these criteria, 89 literature items were selected. Further, additional criteria were introduced for further inclusion:

- 1.Empirical or theoretical research (preference was given to empirical works)
- 2.The study contains scientific novelty
- 3.The paper describes the practical significance of the results
- 4.The study provides new data, not duplicates previous information

¹ Some older studies are also included in the study, as they are known to the authors before the sampling.

Based on these criteria, 40 items of scientific literature were selected.

Data Analysis

For the purpose of data analysis, such criteria as author, year of publication, and results were entered into a Microsoft Word spreadsheet. This was done in order to carry out a theoretical analysis of the selected sources. This method was used to analyze the results contained in these works. After that, the coding method was used, which allowed for a systematic analysis and interpretation of the selected data. It also allowed to find common and different opinions in the studies.

Results

In the 21st century, science and technology are developing very rapidly within education. One of the proofs of the development of science and technology in the educational environment is the presence of new ideas that use computer networks and the Internet in educational activities. In order for innovative learning (based on modern technologies) to function well, teachers and students must be able to master 21st century skills (Tagoe & Cole, 2020). Certain assessment techniques also play an important role in this system. From the selected works, it was possible to establish that summative and formative assessments are important approaches used in the modern 21st century education environment. These approaches differ somewhat from each other. In particular, summative assessment is an assessment that takes place after the completion of a curriculum, when it is considered that the learning is complete (Nieminen et al., 2019). This type of assessment is used for awarding purposes at the end of the learning process, which is structured to systematically record the overall achievement of students. This assessment does not directly impact learning, but the results of this assessment often have an impact on students' subsequent academic performance. Formative assessment, on the other hand, is an assessment that is conducted through the systematic collection of data on the improvement of student learning outcomes in terms of the awareness of competencies acquired or learning materials processed (Ningrum et al., 2018). This information is then summarized and decisions are made about the most effective learning activities for students to maximize their understanding of the competencies taught. Formative assessment is also called assessment for learning. The Table 1 compares the use of formative and summative assessment in the modern educational process.

Table 1

The comparison of using formative and summative assessment

Formative	Summative
Objectives	Objectives
Support for learning Obtaining feedback to optimize the scope of control over the results of students and improve the acquisition of knowledge in general	Evaluation of the final results of training of education seekers Learning support Checking the main achievements of students during a certain academic semester
Process	Process
Formative assessment is carried out throughout the entire course. This may include the implementation of various initial projects, surveys, and daily multi-level tasks	Summative training is carried out after the end of the academic semester. This is mainly carried out with the help of various tests, exams, final projects
Availability of feedback	Availability of feedback
+++ Feedback is regular and frequent	+ \ -

	Feedback is not as frequent. It often takes the form of a final evaluation
Advantages	Advantages
Supports active learning	Facilitates assessment of overall student achievement
A personality-oriented approach is implemented	Assessment of achievement of standards
Increases student motivation	Provides objective measurement of students' progress
Facilitates the adaptation of training to the individual needs of students	

Source: authors' development

Thus, summative assessment serves as a final assessment of student performance. This type of assessment is aimed at determining the basic level of student achievement and obtaining a final grade (Ahmad, 2020). The advantage of this type of assessment is that students receive an objective assessment of their results. Examples of summative assessment implementation:

1. Final tests in the form of exams or quizzes
2. Implementation of final projects
3. Course work
4. Diploma projects

On the other hand, formative learning is carried out during the direct implementation of the educational process and is more frequent. Besides, the formative type is aimed at fast feedback (Phuong et al., 2024; Rahman, 2016). Examples of formative assessment implementation are:

1. Research, discussions, conversations
2. Surveys, quizzes
3. Group discussions
4. Individual and collective projects
5. Practical exercises and independent work
6. Laboratory work
7. Homework assignments

Thus, different assessment methods can be either formative or summative (depending on the purpose of their use). Assessment tools such as rubrics or e-portfolios can be used for both types of assessment. In this way, it is fashionable to implement both procedural feedback and summative assessment. Also, methods such as multiple-choice questions or concept maps can also be used for both types of assessment (Saavedra & Opfer, 2012). This in turn emphasizes their practicality and versatility.

Table 2 demonstrates that most assessment methods can include different forms of assessment: peer-to-peer, collaborative (teacher-student), self-assessment, and teacher assessment.

Table 2*Comparative Table of Assessment Methods*

Assessment Method	Formative (F) or Summative (S)	Peer assessment	Collaborative assessment (teacher-student)	Self assessment	Teacher assessment
Category	F /S	Yes	Yes	Yes	Yes
Netfolio	F /S	Yes	Yes	Yes	Yes
Multiple choice questions and concept maps	F /S	Yes	-	Yes	Yes
Reflective journal	F	-	Yes	Yes	Yes
Comprehensive final exam	S	-	-	-	Yes
Projects and research reports	F /S	-	-	-	Yes
Case analysis and reports	F /S	Yes	-	Yes	Yes
Blogs, collective or individual projects	F /S	Yes	Yes	Yes	Yes
Computer adaptive testing	S	-	-	-	Yes
E-portfolio	F /S	Yes	Yes	Yes	Yes

Source: authors' development

The 21st century education system should emphasize the assessment of skills and competencies that are important for students' future careers. Among these skills, modern researchers emphasize such skills as critical thinking, creativity, information competence, collaboration, and communication. These skills are important indicators for modern assessment in 21st century education (Basnal, 2022; Saavedra & Opfer, 2012; Lane & Tierney, 2008). In particular, the development of critical thinking contributes to making carefully considered and independent decisions, while creativity skills allow you to approach a problem in a non-standard way and always find new ways out of difficult situations. Social skills, such as collaboration and communication, also play an important role in this system, as they are essential for adaptation in today's fast-changing world (Shield, 2013). Nevertheless, given the general trends of digitalization, information competence plays an important role. It consists in the skillful use of digital technologies, processing of information obtained from the Internet, and skillful interpretation of digital information.

Table 3

Assessment of skills and competencies: dimensions of critical thinking, digital literacy, collaboration, creativity, communication

Critical thinking	
Methods	Formulation of clear open questions Analysis of problem situations Analysis of cases Design work Debates
Tools	Assessment rubrics Reflective journals Self-assessment Mutual evaluation
Information competence	
Methods	The use of virtual reality Simulation technologies Assessment based on online testing Use of platforms for remote learning Computer adaptive testing Online surveys
Tools	Maintaining an electronic journal Development of e-portfolio Self-assessment Observation
Creativity	
Methods	Design work Individual tasks Brainstorming Case study of the task Visual projects Presentations
Assessment tools	Development of e-portfolio Evaluation of individual work Evaluation of group work Observation
Collaboration/communication	
Methods	Group project Presentations Public speaking Cooperative learning Role-playing Discussions
Assessment tools	Rubrics for assessing oral and written skills Group work assessment Mutual assessment Observation

Source: authors' development

Thus, to develop 21st century skills, it is necessary to combine different assessment methods. At the same time, as can be seen from the previous tables, modern digital assessment methods play an important role, in particular, those based on the use of technology (computer adaptive testing), e-portfolios, online surveys and other digital tools. Computer-based adaptive testing is a set of tests that can automatically adapt to the student's level of knowledge by varying the difficulty of questions based on previous answers. Such tests allow you to determine the exact level of knowledge of students. At the same time, they save time compared to traditional testing. Modern scientists have also evaluated other benefits of such tests, including more accurate assessment and reduced stress levels for students. Besides, the use of e-portfolios has influence to the formation of a digital collection of students' work, in which progress can be determined. This promotes reflection and allows you to see and track the development of 21st century skills. Real-time assessment through online surveys and learning analytics also play an important role in this learning system. This involves collecting and analyzing data on student activity to identify individual learning problems and optimize the learning system as a whole.

Discussion

Given the purpose of the study, which was to comprehensively characterize modern assessment methods, the results showed the importance of using summative and formative assessment in 21st century education. These methods serve different purposes and are aimed at assessment at different times (summative - final assessment, formative - throughout the educational process). These differences have also been emphasized by other scholars who have studied the specifics of using formative or summative learning (Dolin et al., 2017; Gallardo, 2020).

The data also demonstrated the versatility of different methods of student assessment in modern educational processes. At the same time, it was also determined that such 21st century skills as critical thinking, digital literacy, and social skills play an important role. DiCerbo (2014) also emphasized the importance of integrating 21st century skills into the assessment process. The findings clearly confirmed this need, as the methods of formative assessment used can effectively influence the development of critical thinking and collaboration. At the same time, Gilbert (2016) emphasized the importance of assessment and its compliance with modern educational standards, which is also fully correlated with this study. Eltahir et al. (2023) raised the important issue of fairness in online assessment. The findings also take into account methods that ensure transparency and fairness of assessment, in particular, the results emphasize the importance of introducing computer adaptive testing systems and e-portfolio systems, which is generally consistent with the findings of Eltahir et al. (2023). The findings are also consistent with the study by Kumari et al. (2020), which emphasizes the importance of combining formative and summative learning. However, the author focused more on the importance of the practical impact of these assessment systems, as they focused on medical education. In the same study, the authors of the article tried to cover a wide range of educational methods and did not limit themselves to specific learning.

The paper also emphasized the importance of developing information competence, which is also in line with Mphahlele (2022), who emphasized the importance of digital literacy in assessment. The authors of this article also identified the impact of digital tools such as e-portfolios and computer-based adaptive testing but placed more emphasis on their ability to integrate into different educational frameworks. The importance of using modern digital technologies in the current education system has been proven in a number of works (Tinterri et al., 2022; Tomczyk & Walker, 2021; Vasilache, 2022). Zawacki-Richter (2020) also confirmed that the use of digital technologies has influenced the transformation of the education system in general. On the other hand, Guangul et al. (2020) focused mainly on the challenges of online or e-assessment. However, this work, on the contrary, demonstrated

the benefits and further opportunities provided by digital tools (e.g., computer adaptive testing and online assignments) in improving the quality of assessment and the acquisition of 21st century digital skills by students. Linden et al. (2021) identified the importance of the link between student academic achievement and self-organized learning in a summative assessment system. However, this study focuses more on combined assessment methods (formative and summative), which in turn emphasized the importance of their interaction to improve learning outcomes. Thus, the results of this paper are generally consistent with the findings of other scholars. This, in turn, clearly confirms the importance of using innovative assessment methods to assess 21st century skills. However, there are some differences in the emphasis and research settings: this emphasizes the importance of further research in this area. The limitations of this study relate primarily to the chosen methodology, as the research is based primarily on a content analysis of the literature. Among the notable limitations are the lack of consideration of older works and the possibility of subjectivity in the selected works. However, in fact, these limitations only open up new directions for studying this complex topic. In particular, future research should focus on empirical studies of the role of different evaluation methods or a particular evaluation method. These areas are important for further development of this topic and the formation of new conclusions.

Conclusions and Implications

Thus, science and technology are developing rapidly, requiring both teachers and students to master 21st century skills. Not only teaching methods, but also assessment methods play an important role in this. The main approaches are summative and formative assessment. Summative assessment summarizes students' achievements at the end of the learning process, while formative assessment improves learning outcomes in real time through feedback. Some assessment methods, such as rubrics and e-portfolios, can be used for both types of assessment, which is important because it demonstrates their versatility.

Besides, modern assessment should promote the development of skills such as critical thinking, creativity, information competence, collaboration and communication. The development of digital literacy is particularly important, as it allows all learners to actively use and understand technology. The study found that the active use of digital technologies: computer adaptive testing, e-portfolios, online testing platforms and e-assignments is important for ensuring effective learning and assessment in the modern educational environment.

Suggestions for Future Research

This research also opened up new promising areas for further study of the chosen problem. In particular, it is important for further research to take into account not only the current literature, but also to pay attention to older works that characterize the issues of evaluation methods. This will help illustrate the evolution and development of traditional and innovative evaluation methods. Also, for further theoretical studies, it is worth comparing formative and summative learning. This will allow us to study the effectiveness of these methods. However, a particularly important area is the empirical verification of the above methods. For this purpose, it is worth conducting a survey among students and teachers to characterize the impact of different types of assessment on the development of skills and abilities.

Besides, it is also worth studying through empirical research the impact of e-portfolios, online platforms for testing, platforms for creating online tests or other digital tools on the quality of education in the framework of the implementation of control and evaluation. Also, in further research, important attention should be paid to evaluating the impact of digital tools on student motivation, development of critical thinking and other skills.

A vital promising direction is the empirical study of the impact of formative assessment in the system of distance, electronic or online education. This will help determine the features of the practical implementation of this type of assessment and form new methods to ensure high-quality innovative assessment.

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Conflict of Interest

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