DEVELOPMENT OF INTELLIGENT SYSTEMS FOR AUTOMATIC ASSESSMENT OF STUDENTS' ACADEMIC ACHIEVEMENTS

DESENVOLVIMENTO DE SISTEMAS INTELIGENTES PARA A AVALIAÇÃO AUTOMÁTICA DOS RESULTADOS ACADÊMICOS DOS ESTUDANTES

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ABSTRACT

Aims: to analyse the development of artificial intelligence systems for automatic assessment of students' learning achievements. Methodology: to achieve this goal, the scientific methods of analysis and synthesis, content analysis, SWOT analysis, comparison, and typology were used. Results: it has been established that among the key advantages is a significant increase in the objectivity of the assessment of students' knowledge and skills. It is important to consider the acceleration of the process of checking the results, which saves time and effort for teachers. Another important advantage is the provision of real-time feedback during assessment. Scientific novelty: It has been

established that one of the major problems is the possibility of bias and inequality in the educational system. Given that intelligent systems are based on certain algorithms, any bias or false information in the initial data can lead to biased results. Additional challenges include the excessive mechanisation of the assessment process, which does not always allow for the individual characteristics of each student, as well as ensuring appropriate protection of personal data. Conclusions: Intelligent student assessment systems are a powerful tool in countering corruption schemes in the educational system, especially in developing countries.

Keywords: artificial intelligence, participants of the educational process, automation, objectivity, problems.

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Objetivos: analisar o desenvolvimento de sistemas de inteligência artificial para a avaliação automática dos resultados de aprendizagem dos alunos. Metodologia: para atingir este objetivo, foram utilizados os métodos científicos de análise e síntese, análise de conteúdo, análise SWOT, comparação e tipologia. Resultados: foi estabelecido que, entre as principais vantagens, se encontra um aumento significativo da objetividade da avaliação dos conhecimentos e competências dos alunos. É importante ter em conta a aceleração do processo de verificação dos resultados, o que poupa tempo e esforço aos professores. Outra vantagem importante é o fornecimento de feedback em tempo real durante a avaliação. Novidade científica: Foi estabelecido que um dos principais problemas é a possibilidade de parcialidade e desigualdade no sistema educativo. Dado que os sistemas inteligentes se baseiam em determinados algoritmos, qualquer enviesamento ou informação falsa nos dados iniciais pode conduzir a resultados tendenciosos. Outros desafios incluem a excessiva mecanização do processo de avaliação, que nem sempre tem em conta as características individuais de cada aluno, bem como a garantia de uma proteção adequada dos dados pessoais. Conclusões: Os sistemas inteligentes de avaliação dos alunos são uma ferramenta poderosa para combater os esquemas de corrupção no sistema educativo, especialmente nos países em desenvolvimento.

Palavras-chave: inteligência artificial, participantes no processo educativo, automatização, objetividade, problemas.

Introduction

Over the past decade, intelligent systems, and artificial intelligence (AI) have played a key role in transforming educational practices and the process of assessing students' learning achievements. By combining advanced machine learning, natural language processing, and data analytics technologies, intelligent systems have become an integral part of the educational process. They not only provide the ability to automatically assess the learning achievements of students but also open new prospects for personalised learning and individual development of higher education students.

The term "Artificial Intelligence" (AI) first emerged in 1956 during a conference at Dartmouth College, where the possibility of creating and programming machines that could understand and perform tasks previously thought to be exclusively human intelligence was discussed (WOJCIECH *et al.,* 2021). Since then, the concept of AI has gone through numerous stages of evolution and has undergone several important transformations, reflecting the growing complexity and power of intelligent systems. The modern field of artificial intelligence has expanded and is developing dynamically. Recently, the use of AI tools to support and optimise the educational process has become particularly popular (NOWAK, 2017). The main goal of this area is to provide every student with high-quality, personalised, and accessible education that opens opportunities throughout life. AI can also be a key component in the implementation of innovative approaches to knowledge assessment systems, such as adaptive and continuous assessment using it. However, researchers have noted that the use of AI technologies in education and assessment brings with it a number of challenges and problems (DARWISH, 2022). These include contradictory approaches to pedagogical processes, lack of sufficiently convincing evidence of their effectiveness, changing the role of teachers in the learning process, and other ethical issues that require careful consideration and resolution.

Research Problem

One of the main research issues is the accuracy and reliability of such systems. With rapid advances in technology, intelligent systems are becoming increasingly powerful, but it is important to ensure that they are able to assess student learning accurately and objectively. In addition, intelligent systems need to consider the diverse contexts in which learning takes place and the different learning styles of students. This requires the use of systems that can adapt to different contexts and needs, as well as consider individual differences between learners. Issues of ethics and fairness are also important in exploring this issue. Intelligent systems may raise questions about transparency and fair consideration of different groups of students who require an inclusive approach to assessment.

Therefore, the research challenges are to improve intelligent systems for automatic learning assessment that are accurate, reliable, adaptable to different conditions and needs, and ethically and fairly assess students.

Research Focus

This research article aims to examine the innovative possibilities offered by intelligent systems in the context of learning assessment. It examines the evolution of intelligent systems for automatic learning assessment and draws attention to their advantages and limitations. We explore the current methods and technologies used in this process and their impact on the education sector. Focusing on the development and implementation of intelligent systems for automatic learning assessment, it is important to analyse the possibilities of improving learning and the educational process in general. It also discusses the challenges associated with these innovative approaches, such as data privacy, equity, and ethical issues. An important aspect of the work is to help educational institutions and educators better understand the potential of intelligent systems for automatic learning assessment and to identify best practices in their use. It is equally important to review the existing scientific views on the issue, which will help develop the educational sector and contribute to improving the quality of education, making it more individualised, accessible, and effective through intelligent systems.

Research Aim and Research Questions

The aim of the study is to analyse the development of intelligent systems for the automatic assessment of students' academic achievements. The realisation of this goal involves the following tasks identifying the advantages and disadvantages of using artificial intelligence in the process of assessing the knowledge of students.
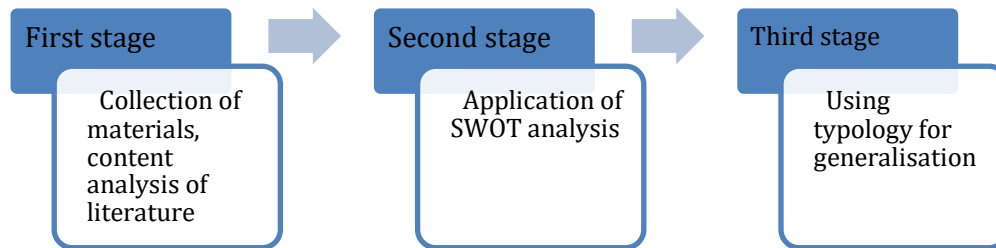
Research Methodology

General Background

The study was based on the use of general scientific research methods. The use of analysis and synthesis contributed to the formation of our understanding of the current state of understanding of the importance of artificial intelligence (AI) technology for assessing the learning outcomes of students. The content analysis method was used to analyse the scientific professional literature on the use of AI. The SWOT analysis method was used to highlight the prospects for the use of AI in assessment, science, and education. SWOT analysis is an effective tool in strategic management, helping to assess the current state and develop a strategy to achieve the goals. The SWOT acronym reflects four main aspects: Strengths, which represent internal positive characteristics and advantages; Weaknesses, which indicate internal negative factors, limitations, and disadvantages; Opportunities, which represent external factors that indicate potential opportunities for the development of AI; and Threats, which are also external factors that may have a negative impact in the future. A SWOT analysis helps to identify how to maximise the use of AI's strengths to exploit opportunities and reduce the impact of weaknesses and threats in the future. The analysis resulted in the formulation of recommendations to achieve success and improve the situation. The typological method was used for qualitative processing and grouping of information. The basics of comparativism were used to compare the strengths and weaknesses of using artificial intelligence for the automatic assessment of learning outcomes.

Data Analysis

The research was divided into several stages. The first stage involved collecting materials and conducting a content analysis of scientific and professional publications. These publications formed the theoretical basis of the study, so special attention was paid to the selection of various sources. The objectivity and comprehensiveness of the future results depended on the breadth of the sample of materials. We used the methods of analysis and synthesis to critically review and

process the collected material, which served as the basis for drawing conclusions while summarising the results (see Figure 1).

Figure 1 – Stages of the study

| First stage | | Second stage | | Third stage |

Collection of materials, content analysis of literature → Application of SWOT analysis → Using typology for generalisation

Source: compiled by the authors.

At the second stage, a SWOT analysis was used to structure and present the materials, as well as to identify prospects for further research. The SWOT analysis helped to assess the strengths and weaknesses, as well as opportunities and threats of using artificial intelligence in the assessment of students' work. At the final stage of the study, the typological method was used to summarise the results and summarise the findings of the study.

Research Results

Intelligent Learning Systems and the Problem of Knowledge Assessment: Current Status and Prospects

Among the variants of artificial intelligence (AI) that are most widely used in education, a special place is occupied by intelligent learning systems (ILS). An intelligent learning system is a complex set of technologies that use AI to improve the learning process and facilitate the most effective level of perception and assimilation of knowledge by students (GIRÓ GRÀCIA and SANCHO-GIL, 2021). These systems work on the basis of data analysis, machine learning technology, and

other innovative methods that allow for individualised approaches to learning, taking into account the specific characteristics and needs of each student.

Intelligent learning systems can be useful in a wide range of educational contexts, including distance learning, general education and higher education, corporate training, and inclusive education, among others (ALAN SHER MALIK, 2021). The multidimensional nature of ICTs means that they help students learn more effectively and teachers to provide an individualised approach to the learning process (see Figure 2).

Figure 2 – Key features of intelligent learning and assessment systems
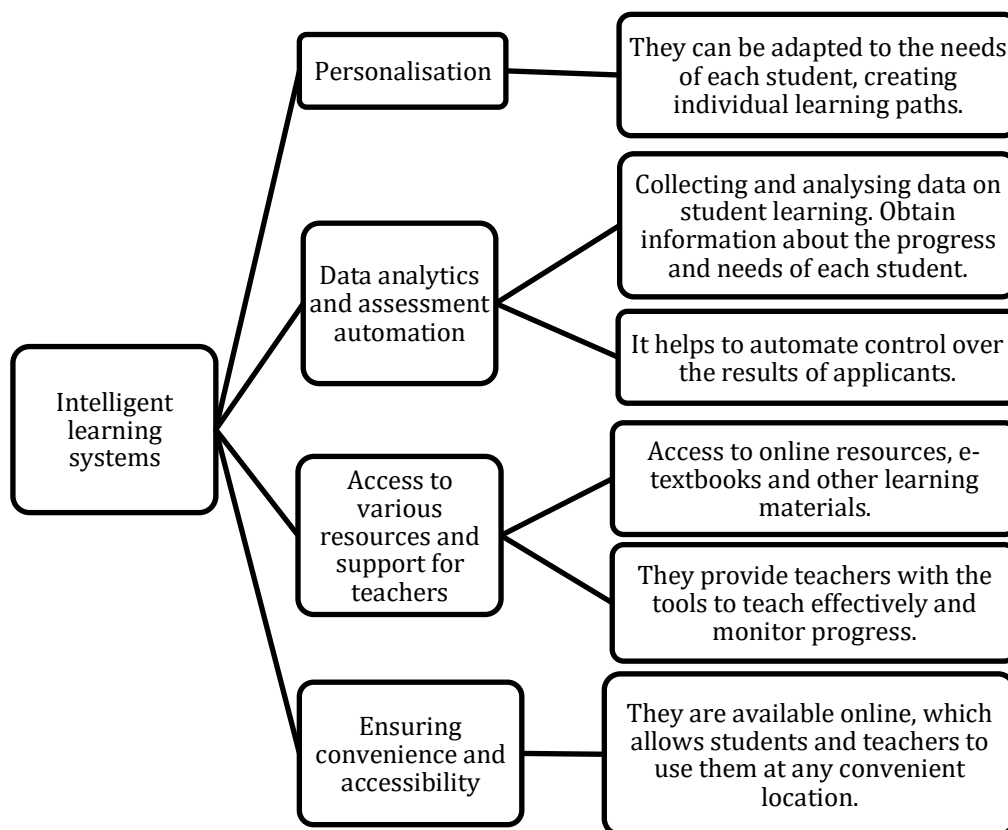
Source: compiled by the authors.

In general, the function of intelligent tutoring systems (ITS) is to provide individualised learning steps for each student. The system determines the optimal path for learning the material, considering the learner's level of knowledge of the

discipline, and responds to the difficulties or successes of each individual learner (ALAM, 2022). In the learning process, ILNs use knowledge tracking and machine learning algorithms to automatically adjust the difficulty level of tasks and provide hints or recommendations according to individual student strengths and weaknesses. This contributes to more effective learning. Furthermore, ICTs collect and analyse data about a student's emotional state to understand their attention span. ILIs can provide personalised recommendations, create individualised assignments, and track student progress, needs, abilities, and learning pace (KULKARNI; TOKSHA; GUPTA, 2022, p. 95-97).

They are used in various fields of education, from general school education to corporate training, providing a more effective and individualised approach to learning (KNOX, 2020). One example of a successful implementation of personalised learning is the Thinkster system, where users take a test and then the LMS provides an individualised learning plan. Another example is DreamBox Learning, a specialised resource for learning mathematics that uses adaptive algorithms to select tasks that match the level of each student and allow them to assess their progress. Similarly effective is the Blackboard platform, which provides tools for creating interactive digital courses, evaluating the results of their implementation, and conducting analytics to track learning progress.

Therefore, the use of artificial intelligence in education has significantly increased the objectivity of assessing students' knowledge and skills through the use of standardised algorithms and assessment criteria. The system can use machine learning methods to analyse texts to determine the level of students' awareness of a particular topic and to identify cases of plagiarism and copying (LAMPOU, 2023). At the present stage, artificial intelligence technologies are widely used in developed European countries to evaluate student responses in surveys and provide feedback. This saves up to 80% of the time and resources that would otherwise be spent by teachers (approximately two weeks of work for a teacher) to perform similar work in the traditional way.

One of the key opportunities offered by AI in the student assessment process is the ability to provide real-time feedback (PALSHKOV *et al.*, 2023). AI-powered

assessment tools can instantly analyse student responses and performance data, enabling teachers to identify areas where students may be struggling and provide immediate support. This capability helps to improve students' understanding of the material and increase their academic achievement. In addition, AI can also identify patterns in student performance, allowing teachers to tailor their teaching methods to the needs of each individual student.

Another advantage of using artificial intelligence in student assessment is the ability to increase the objectivity and fairness of the assessment process (SHEIN MINN, 2022). Traditional assessment methods, such as exams and essays, can be affected by human biases and errors. On the other hand, AI algorithms can be developed to assess student performance based on predefined criteria, reducing the possibility of subjective assessments (LAIRD; LEBIERE, and ROSENBLOOM, 2017). This contributes to more accurate and consistent results. For example, AI-based educational games and simulations can be used to assess students' problem-solving, critical thinking, and collaboration skills, creating an engaging and enjoyable learning environment (MARIONO and SABAR, 2023). This in turn can increase student motivation.

Difficulties in using AI to assess outcomes in education

In general, researchers agree on the prospects of using AI systems for independent assessment in the educational process (JOSHI; RAMBOLA; CHURI, 2021). At the same time, despite the promising prospects, the introduction of artificial intelligence in the process of assessing students is accompanied by several problems (see Table 1).

Table 1 – Obvious problems in using AI systems to assess students' knowledge

Problem	Characteristics and possible solutions
Prejudice and inequality in the education system	One of the main risks of working with AI in general. AI algorithms may retain existing biases, as AI systems are trained on large amounts of data, and if this data contains biased or inadequate reflections of reality, AI algorithms may produce unfair results, as computer intelligence systems are currently unable to distinguish between fake and reality. This can lead to unfair grades and further deterioration of the situation of already underachieving students. To solve this problem, it is crucial to ensure that AI algorithms are developed and trained using diverse and representative data. In addition, ongoing monitoring and evaluation of AI systems is necessary to identify and mitigate any potential biases that may arise in the course of their use.
Potential loss of human contact during the assessment process	While AI systems can provide valuable information and streamline the assessment process, it is important to leave room for the notion that human judgement and understanding are still important components of successful education. Educators need to find a balance between harnessing the power of AI and maintaining a personal touch with their students.
Data privacy and security	Concerns about gaining unauthorised access to students' personal data are well-founded, as access to assignments is provided through digital channels that are not always properly protected. Collecting and analysing large amounts of student data can pose a threat to the confidentiality of their personal information and is vulnerable to potential breaches. For this reason, it is important to establish robust data security measures and ensure that students are clearly informed about how their data is used and protected.

Source: compiled by the authors based on KOOS (2018), BAGUNAID, CHILAMKURTI, and VEERARGHAVAN (2022), AJAMI and KARIMI (2023).

In addition, there are still unclear problems with the use of artificial intelligence in assessing students' work. This issue is much less researched. In particular, a computer system may face such difficulties as misunderstanding the context. First of all, artificial intelligence algorithms may have difficulty accurately understanding and interpreting complex contexts, especially in the humanities or other areas where the text may contain many nuances and subtleties. This directly affects the formation of creativity and originality scores. Some algorithms may have problems with this, especially when assessing creative aspects of works such as literature, art, or design. They may underestimate the originality and individual approach of students. Similarly, it is difficult for AI systems to take into account writing style because different students have different styles of expressing their thoughts in writing. Algorithms may be inclined to give incorrect scores due to incompatible styles or dialectics, even though the answers may be correct in nature.

The other side of the problem is the need for large training datasets. In fact, in practice, for artificial intelligence algorithms to work effectively, a huge amount of data is required to organise training. Ideally, this should be a variety of data that reflects the different styles and methods of students' approach to tasks. However, the capabilities of modern computer systems are limited, so they are suitable primarily for processing simple answers in the humanities and for testing and assessing knowledge in the sciences, when it comes to mathematical formulas, physics problems, etc. Obviously, the challenge today is to create the necessary data environment for AI to be able to evaluate the work of those applicants with personal writing styles in an unbiased and complete manner. At the same time, the seemingly simple solution is technically complex and extremely difficult to implement in practice, as it may require the development of new software for training and self-learning of AI. The solution to this problem has demonstrated the limitations of the proposed ways to solve other issues and is a promising area for further research (LEE and LEE, 2021). This refers not only to the technical aspect of the problem but also to its philosophical basis, related to the phenomenon of learning and self-learning of computer systems and the possibilities for their use in education.

Discussion

The scientific debate on the possibilities of using artificial intelligence (AI) in assessing student learning is an important part of the discussion of modern technological and pedagogical innovations in education (LEE and LEE, 2021). This topic provokes lively discussions and debates among educational professionals, researchers, teachers, and students. As demonstrated, the benefits of using AI in student assessment are undeniable (TSOLI, 2021). Researchers note the objectivity and continuity of AI, which can provide objective assessments using standardised algorithms and criteria (CHEN; CHEN; LIN, 2020). Equally important are efficiency and speed, which can significantly automate the assessment process and save teachers' time. No less relevant in modern educational paradigms is the factor of personalisation of learning: the use of AI allows for individualised approaches to student learning, considering their needs and abilities, and at the same time properly assessing their work.

Researchers also note challenges and limitations (HUTSON, 2018). First of all, we are talking about the security factor, which in the era of cybercrime is generally relevant for all users of the digital environment. The work of AI with the collection and storage of students' data may raise questions about privacy and security. In many aspects, the use of AI can lead to a loss of human contact and empathy, which are important in terms of effective education (CHIU, 2023). This is especially true in the assessment of those learning tasks and subjects where AI may be less effective. Especially at the current stage of development, it is difficult for artificial intelligent systems to correctly assess the level of creativity, critical thinking, and other skills of students.

All of these aspects integrate into a complex debate about how to maximise the potential of AI in student assessment, while maintaining a balance between the use of technology and preserving the important interpersonal aspects of education (MILLER, 2019; SEIN MINN, 2022). Summing up the views of scholars, the use of artificial intelligence to assess the level of knowledge of students opens numerous

opportunities to improve the accuracy, efficiency, and personalisation of the assessment process.

At the same time, the use of artificial intelligence systems in assessing students' learning outcomes has several additional advantages that are particularly important for third world countries that have just embarked on the path to European integration. First, we are talking about corruption risks. Since artificial intelligence mechanisms operate on the general principles of objectivity and impartiality, they cannot be bribed or otherwise influenced in their decisions. In such circumstances, grades for students will not be assigned with a corrupt component but will depend on the level of knowledge and skills. This factor is extremely relevant for countering unfair assessment (LAMPOU, 2023). For European and North American countries, this advantage is not so important due to the low level of corruption in society. At the same time, the introduction of similar methods in countries with a much higher level of corruption schemes can improve the situation towards impartiality even in the humanities. We are talking about taking exams with the use of computer intelligence, which will independently determine the level of knowledge of the applicant and, importantly, publish this result in the public domain. Although, according to researchers, it is not customary in European countries to show the grades of other students in general, this simple technique can prevent deliberate bias in the assessment of student work (ALAM, 2022; WOJCIECH *et al.*, 2021). This aspect has not received much attention in the scientific literature, although its value for solving quite practical problems is obvious.

Instead, a significant drawback of using AI in learning outcomes assessment is that there is a debate in the research community that AI-assisted assessment is not a neutral platform capable of identifying and assessing all forms of learning without bias. Like any other form of assessment, it can be argued that AI-assisted assessment inevitably encodes specific cultural, disciplinary, and individual norms, value systems, and knowledge hierarchies. Furthermore, it has the potential to inculcate these norms, values, and knowledge hierarchies in learners (SWIECKI *et al.,* 2022). Learners can adapt their performance according to what is

algorithmically assessed. In other words, the practice of "studying for the exam" cannot necessarily be eliminated through the use of AI-assisted assessment.

Conclusions and Implications

Therefore, the use of intelligent systems for automatic assessment of students' learning achievements has its advantages and disadvantages. The main advantages include a significant increase in the objectivity of the assessment of students' knowledge and skills. It is also important to identify the acceleration of the process of checking results, which saves time and effort for teachers and allows them to focus on other tasks and current problems. An important aspect is to provide feedback in the assessment process in real time: individual students may have different knowledge on different topics, so the use of AI will help identify problem areas in their professional training. Some of the biggest challenges to using AI in the assessment of student work include bias and inequality in the education system. The point is that AI is based on certain algorithms, so if the information used by the intelligent system contains certain biases or false information, it immediately affects the assessment. Other current challenges are the excessive mechanisation of the assessment process, which rejects the possibility of considering the style of each student, and the protection of personal data, which is generally a significant danger when working with any digital environment. In addition, it is worth noting that intelligent systems for assessing students' knowledge are valuable example of countering corruption schemes in education, which are typical for developing countries. The use of artificial intelligence in these countries will help monitor unfair and biased assessments. On the other hand, an important topic for further research is the technical improvement of AI, which would allow for effective work with assessments not only in the technical sciences, but also in the humanities.

Suggestions for Future Research

Given that the development of intelligent systems for automatic assessment of students' learning achievements is a broad and promising research topic, future research in this area may cover several important areas. In particular, an important area is to analyse the development of new assessment algorithms. Obviously, to improve the accuracy and objectivity of assessment, it is necessary to develop more complex and accurate algorithms that take into account various aspects of learning, including creativity, critical thinking, and problem-based approach. This area will be an important aspect for further research that will have practical and applied value. Another area of theoretical and practical importance is research on the development of interactive systems. We believe that future research could focus on the development of interactive systems that work together with teachers and students on assessment and learning. Such systems can stimulate the active participation of students in their own learning and help teachers to adapt the learning process. At the same time, modern scientists can explore how intelligent systems can be configured to take into account the individual characteristics and needs of students. This could include adapting tasks, assessment methods, and recommendations for each student. Future research should also improve ethical standards and transparency in the use of intelligent assessment systems. It is important to develop standards and rules that guarantee the rights and privacy of modern students. We also note that future research could explore the possibility of introducing dynamic assessment that takes into account changes in the learning process over time. This can help track the development of students and provide timely support to each participant in the educational process. Thus, the issue of developing intelligent systems for automatic assessment of students' learning achievements has great potential for improving the educational system. Future research in this area can contribute to the creation of more efficient and inclusive systems that will help students achieve greater academic success.

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