

Automated Creation of Educational Questions: Analysis of Artificial Intelligence Technologies and Their Role in Education

Todor Rachovski
Faculty of Mathematics and
Informatics
Plovdiv University "Paisii
Hilendarski"
Plovdiv, Bulgaria
todormr@gmail.com

Desislava Petrova
Department Management
Technical university of Gabrovo
Gabrovo, Bulgaria
des_petrova@abv.bg

Ivan Ivanov
Faculty of Mathematics and
Informatics
Plovdiv University "Paisii
Hilendarski"
Plovdiv, Bulgaria
ivanivanov1040@gmail.com

Abstract. This study explores the integration of artificial intelligence (AI) in education, focusing on its potential benefits and challenges. Through an in-depth analysis of contemporary AI platforms and software technologies, it examines their suitability for educational environments. The study highlights AI's capacity to enhance personalized learning experiences, facilitate educational gaming and simulations, and support teachers in various tasks. However, ethical considerations regarding data privacy and algorithmic bias, as well as technical challenges related to software reliability, require careful attention. By providing insights into the transformative potential of AI in education, this research aims to inform stakeholders about the opportunities and risks associated with its implementation.

Keywords: Artificial Intelligence (AI), educational technology, personalized learning, ethical considerations, technological challenges, algorithmic bias, data privacy.

I. INTRODUCTION

In recent years, the advancement of technology in the field of artificial intelligence (AI) and machine learning has transformed numerous aspects of our world, including education. The ability to use artificial intelligence for algorithmic generation of test questions from text introduces new opportunities for optimizing the educational process. This methodology involves the utilization of AI algorithms for analyzing educational resources and generating exam tests and questions. Such technology not only streamlines the time and efforts of educators but also offers opportunities for personalized and adaptive learning. Natural Language Processing (NLP) plays a pivotal role in this process, enabling computer systems to "understand" and process human language texts, extract significant information, and generate relevant questions [1]. Thus, artificial intelligence has the potential

to change traditional methods of creating educational resources, offering a personalized, scalable, and efficient approach. This material provides a comprehensive overview of various contemporary artificial intelligence platforms used for generating test questions, along with their applications and significance in the educational context. It examines the technologies behind these platforms, their advantages, challenges, and potential ethical issues. It explores how algorithmic generation of test questions using artificial intelligence can alter the educational process [2]. The primary aim of this publication is to examine the transformative potential of artificial intelligence technologies in the education sector. By conducting a thorough review of modern artificial intelligence platforms and their applications in test question generation, the document aims to highlight how these advanced tools can optimize and enrich the educational process. The focus is not only on technological capabilities and innovations but also on understanding the ethical implications and practical challenges accompanying the integration of artificial intelligence into educational environments [3]. The goal is to provide educators, policymakers, and technology developers with a comprehensive overview of the role of artificial intelligence in education, encouraging informed decision-making and strategic implementation to improve learning outcomes.

II. MATERIALS AND METHODS

In this section, we will explore the key technologies and processes used for automated generation of educational questions. Our analysis will focus on question generation technologies, integration with educational platforms, as well as analysis and evaluation of the questions. Question Generation Technology: We will examine various

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technologies used for algorithmic creation of questions from educational texts. These technologies include Natural Language Processing (NLP), Machine Learning, Semantic Analysis, Automated Summarization, and Fact Extraction. We will investigate how these methods assist in generating suitable and diverse questions appropriate for the context and difficulty level of the material. We have identified several key technologies used for automated generation of educational questions:

- Natural Language Processing (NLP): We utilize NLP for analyzing educational texts and extracting important information for transformation into questions [4].
- Machine Learning: We employ machine learning algorithms trained on large datasets of educational resources to generate suitable and diverse questions [5].
- Semantic Analysis: We utilize semantic analysis technologies to understand the deep meaning of words and phrases in the text and to identify suitable themes and concepts for the questions [6].
- Automated Summarization: We use automated summarization technologies to condense lengthy texts into shorter versions that describe the main ideas [7].
- Fact Extraction: We utilize fact extraction technologies to identify and extract key facts, dates, names, and relationships between objects in the text to create questions that require memorization and recall of specific data [8].

Integration with Educational Platforms: There are several existing educational platforms and learning management systems that allow question generation technologies to integrate directly into the educational process [9][10]. Table 1 presents the main platforms, along with their key functionalities and applications in the field of generating educational questions.

TABLE 1

AI Platform	Core Functionalities	Application in Question Generation	Unique Features
GPT (OpenAI)	Utilizes deep learning to generate human-like text based on the input provided. Capable of understanding and generating natural language responses.	Can create nuanced and contextually relevant test questions by processing educational content.	Exceptional at producing creative and varied questions, adapting to different subjects and complexity levels.
BERT (Google)	Focuses on interpreting the structure of sentences and the context of words within them, using bidirectional training.	Excellent suited for generating detailed and specific questions that require a deep understanding of the text.	Its bidirectional nature allows it to understand text context more deeply than other models, leading to highly relevant question generation.

Watson (IBM)	Offers robust natural language processing capabilities with a focus on understanding semantics and nuances in language.	Efficient in generating a wide range of question types by analyzing complex datasets and educational materials.	Notable for its industry-specific solutions, making it versatile for generating discipline-specific educational content.
Azure AI (Microsoft)	Provides a comprehensive suite of AI tools including language understanding, speech, and decision-making capabilities.	Capable of automating the generation of questions across various subjects, scaling according to educational needs.	Stands out for its scalability and the integration of various AI services, offering a holistic approach to question generation.
Baidu's PaddlePaddle	Deep Learning and Machine Learning	Suitable for developing personalized and adaptive educational platforms.	Strong focus on Chinese language and machine learning.
SAS Viya	Analytical tools and machine learning capabilities.	Analysis of educational outcomes, personalization of learning plans.	Flexibility and power in analyzing large volumes of data.
Salesforce Einstein	Integration with cloud CRM services, data analysis.	Management of interactions with learners, analysis of their behaviour and performance	Various analytical functionalities integrated into the CRM platform.

Feedback Analysis and Evaluation: The technologies for feedback analysis and evaluation, which analyze students' responses and feedback, aim to improve the quality and relevance of the generated questions [11]. These technologies not only analyze students' responses but also monitor their learning process and reaction to the generated questions. Through feedback analysis and evaluation, we can identify the strengths and weaknesses of the questions, allowing us to adapt and improve our question generation methods, thus providing more suitable and effective educational tools.

III. RESULTS AND DISCUSSION

The present study explores contemporary artificial intelligence (AI) platforms used for generating test questions and optimizing the educational process. Analysis of the practical applications of these technologies led to the following key conclusions, supported by specific examples:

- Efficiency: Artificial intelligence significantly reduces the time required for creating test questions and improves their accuracy and relevance. The "Carnegie Learning" system utilizes machine learning to adapt educational material to the learning needs of each student, leading to increased success and engagement. This technology notably decreases the time needed for generating test questions and enhances their accuracy and relevance.

- **Personalization:** AI platforms successfully tailor educational content to the individual needs of students. Tools like Turnitin and IBM Watson Education provide automated assessments, facilitating classroom management and offering deeper personalized engagement for students. These platforms effectively adjust educational content according to the individual needs of students [12].

- **Scalability:** Artificial intelligence facilitates scaling the generation of test questions according to the needs of various educational institutions or student groups, allowing rapid adaptation of educational programs and materials. For example, Microsoft Azure AI facilitates scaling the generation of test questions according to the needs of different educational institutions [13]. This platform enables rapid adaptation of educational programs and materials, making it exceptionally useful for scalable education.

In addition to these positive aspects, the research also highlights certain challenges:

- **Ethical Issues:** The use of AI in education requires a strict balance between innovation and protecting students' personal data. It is important to ensure that AI systems are used in a manner that respects the rights and confidentiality of students.

- **Technical Limitations:** The complexity of educational content and the diversity of learning needs necessitate continuous development of AI platforms to adequately process and integrate new educational methodologies and technologies. Platforms must adapt to specific educational systems and maintain high standards of accuracy and reliability to ensure effective and quality learning [14].

IV. CONCLUSIONS

Undoubtedly, artificial intelligence provides powerful tools with the potential to revolutionize education. Their use allows educational institutions to optimize various aspects of the educational process, such as:

- **Personalized Learning:** Artificial intelligence can be used to create personalized educational experiences tailored to the individual needs of each student [15]. This can be achieved through analyzing learning data and student performance to identify their strengths and weaknesses.

- **Educational Games and Simulations:** Artificial intelligence can be used to develop educational games and simulations that are more engaging and effective than traditional instructional materials.

- **Teacher Support:** Artificial intelligence can be used to develop assistants that help teachers with various tasks, including lesson planning, classroom management, and providing personalized educational support to students [16].

- **Expanding Access to Education:** Creating online courses and platforms accessible in remote geographical areas increases access to education.

However, it is important to consider some challenges posed by the use of artificial intelligence:

- **Ethical Issues:** It is crucial to ensure that artificial intelligence systems are not used for discrimination or exacerbating existing inequalities.

- **Practical Challenges:** Software systems need to be developed that are reliable, accurate, and accessible, with a focus on data protection [17].

To address these challenges, educational institutions, researchers, and software developers must work closely together. Only through careful planning and implementation can artificial intelligence be used to create a better future for education.

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REFERENCES

- [1] L. Chen, Q. Liu, 2020. Enhancing Personalized Learning with Artificial Intelligence in Education. *International Journal of Artificial Intelligence in Education*, 30(3), 456-478
- [2] K. Soh, L. Lim, A survey on automatic question generation for educational assessment. *Educational Technology & Society*, 23(3), 220-235 (2020).
- [3] G. Cetin, M. Kayacik, The use of chatbots in education: A systematic review of the literature. *Educational Technology Society*, 24(3), 174-191 (2021).
- [4] N. Mostafazadeh, M. Mostafazadeh, Automatic question generation for educational contexts: A survey. *ACM Computing Surveys (CSUR)*, 51(2), 1-36 (2018).
- [5] T. Nguyen, H. Hoang, Automatic question generation for educational purposes: A systematic review. *Education and Information Technologies*, 24(3), 2213-2240 (2019).
- [6] V. Aleven, McLaren, A new paradigm for intelligent tutoring systems: Example-tracing tutors. *International Journal of Artificial Intelligence in Education*, 19(2), 105-154 et. al. 2009.
- [7] Y. Li, B. Zhang, Artificial intelligence in education: A review of recent research. *Educational Technology and Society*, 25(1), 192-211 (2022).
- [8] C. Conati, K. Vanlehn, Towards computer-based support of meta-cognitive skills: A computational framework to coach self-explanation. *International Journal of Artificial Intelligence in Education*, 20(4), 377-412 (2010).
- [9] N. Mostafazadeh, M. Mostafazadeh, Automatic question generation for educational contexts: A survey. *ACM Computing Surveys (CSUR)*, 51(2), 1-36 (2018).
- [10] C. Chen, C. Chang, A neural network-based question generation approach for educational assessment. *IEEE Transactions on Learning Technologies*, 15(2), 223-233 (2022).
- [11] C. Chou, W. Wang, Artificial intelligence in education: A review of recent research. *Educational Technology and Society*, 21(3), 82-102 (2018).
- [12] Y. Hwang, K. Chang, The use of artificial intelligence in education: A systematic review of research on benefits, challenges, and future directions. *Educational Technology & Society*, 25(1), 212-233 (2022).
- [13] M. Khan, R. J. Mislevy, The future of automated scoring. *Educational Measurement: Issues and Practice*, 37(3), 2-10 (2021).
- [14] T. Brown, B. Mann, N. Ryder, Subbiah, (2020). Language models are few-shot learners. *arXiv preprint arXiv:2005.14165* (2020).
- [15] Y. Cai, A survey of automated scoring for educational assessments. *ACM Computing Surveys (CSUR)*, 55(2), 1-35 (2022).
- [16] I. Hsiao, J. Yang, Artificial intelligence in personalized learning: A systematic review. *IEEE Transactions on Education*, 63(3), 276-291 (2020).
- [17] A. Holton, The impact of artificial intelligence on learning, teaching, and education. *Journal of Educational Technology Development and Exchange*, 11(1), 68-84 (2018).