



# ADVANTAGES, PROBLEMS AND CHALLENGES IN THE APPLICATION OF AI TECHNOLOGIES IN SCHOOL EDUCATION

Todorka Glushkova<sup>1</sup> & Anna Malinova<sup>2</sup>

University of Plovdiv, 24, Tzar Asen str., 4000 Plovdiv, Bulgaria

<sup>1</sup> [glushkova@uni-plovdiv.bg](mailto:glushkova@uni-plovdiv.bg), <https://orcid.org/0000-0002-6243-9364>

<sup>2</sup> [malinova@uni-plovdiv.bg](mailto:malinova@uni-plovdiv.bg), <https://orcid.org/0000-0002-1266-4782>

**Abstract:** *The implementation and use of AI technologies in education offer great potential for increasing the quality of student learning, as well as assisting teachers in organizing the educational process. However, the use of AI in education (AIEd) also raises some important ethical questions. The article discusses some aspects of applying some AI technologies to improve personalization, accessibility, and interactivity in school education. The authors aim to share their experience in successfully integrating AI into the classroom while focusing on the ethical and responsible use of these technologies.*

**Keywords:** Artificial Intelligence in Education, Chatbots, Personalized learning

## INTRODUCTION

The development of Artificial Intelligence (AI) has created conditions for changes and transformations in all spheres of life, including education. AI technologies have the potential to alter and modify traditional approaches, methods, and teaching and learning technologies. AI applications are already being used to some extent in various aspects of school education, including establishing and analyzing learning outcomes, personalizing educational resources and the learning process, providing immediate feedback, and engaging students.

The implementation and use of intelligent learning platforms that include personalized learning and assessment systems offer great potential for increasing students' knowledge, building essential key competencies, and assisting teachers in organizing personalized education. The expectations are that providing a learning environment tailored to the personal expectations, requirements, goals, and interests of each student, will lead to increased student engagement and motivation, thereby enhancing the effectiveness of the learning process.

Despite these advantages, the use of AI in education (AIEd) also raises important ethical questions and issues. These issues are largely related to the exacerbation of existing inequalities in the educational system because AI algorithms often tend to perpetuate biases and distort information embedded in machine learning algorithms. Additionally, for teachers to effectively use AI in their teaching practices, they require appropriate training and support.

The article discusses some aspects of implementing certain AI tools and chatbots to enhance personalization, accessibility, and interactivity in school education. At the same time, the authors intend to focus attention on the ethical and responsible use of these technologies.

## 1. AI IN EDUCATION – AIED

The possibilities offered by AI are becoming increasingly tangible. It has the potential to change all aspects of public life – business, tourism, agriculture, healthcare, and education. Artificial Intelligence, as defined by John McCarthy in the distant year 1955, refers to that machines can perform tasks that typically require human intelligence. In contemporary terms, we can consider any theory, methodology, or technique that facilitates the analysis, simulation, and investigation of human thought processes and behavior by machines, as AI. Intelligent systems encompass a broad range of technologies and fields such as cognitive robotics, natural language processing, sound and image recognition, expert systems, neural networks, machine learning, etc. (Sarker, 2022).

### 1.1. AIEd Paradigms

The application of AI in the process of formal and informal learning is the subject of intensive scientific research. AI is considered a powerful tool for creating new paradigms in instructional design, technological advancement, and educational research that would otherwise be difficult to achieve through conventional methods. Ouyang and Jiao (2021) articulate three AIEd paradigms:

- **AI – directed learning.** In this paradigm, AI is used to introduce cognitive learning tools, with learners in the role of recipients of AI services.
- **AI – supported learning.** In this paradigm, through the application of various cognitive and social constructivist theoretical foundations, AI supports learning. Students collaborate with AI to obtain desired knowledge, skills, and competencies.
- **AI – empowered learning.** This paradigm is based on collaboration, with artificial intelligence empowering learners to take initiative in their own learning, and collaboration between student, facilitator, mentor, information, and technology increasing the added value of learning.

There are two distinct approaches in AIEd, consisting of developing AI-based tools for classrooms on the one hand and using AI to gain insight, assess and improve learning on the other. AIEd includes the integration of different social, cultural, economic, and pedagogical approaches in the use of AI technologies such as intelligent

learning cyber-physical systems (Stoyanov, 2022), chatbots, learning robots, learning tracking and analysis tools, adaptive learning systems and automated assessment, etc. One of the most commonly used AI technologies to support teaching and learning activities is the utilization of Chatbot technology (Deng et al., 2023). By nature, a Chatbot is an intelligent agent that engages in meaningful conversations with users, thanks to a well-structured knowledge base. Creating a Chatbot is based on Natural Language Processing (NLP) technologies. The first Chatbot Eliza, was developed to act as a psychotherapist as early as 1966. As technology advanced, numerous Chatbots were created, including SmarterChild, Apple Siri, Amazon Alexa, IBM Watson, Microsoft Cortana, Google Assistant, and more.

## 1.2. Chatbots in the Classroom

In the past few months, some of the popular chatbots like ChatGPT and Microsoft 365 Copilot have quickly caught on in the classroom. We will look at some of their functionalities through the lens of school education. ChatGPT was created by OpenAI and launched in November 2022. ChatGPT is described as a powerful machine learning software that uses the Generative Pre-trained Transformer (GPT) algorithm to generate answers to text questions. A wide range of tasks can be performed by ChatGPT, including language translation, answering questions, creative writing and generating long or short content, explaining complex concepts or topics, generating, or debugging programming code, and more. ChatGPT's ability to understand natural language queries and generate responses has made it a popular tool for getting quick answers to a wide variety of questions in the classroom. For example, it can quickly summarize a long and difficult topic in a few sentences. It not only discovers what the problem is but also provides descriptive solutions to math and physics problems; can assist in the detection of programming errors; to comment and explain program fragments and modules.

Another AI chatbot that can be effectively used in school education is Microsoft 365 Copilot as it aims to improve collaboration between participants in the educational process and facilitate teamwork in the implementation of educational projects. It provides personalized, AI-driven advice and suggestions that can help teams accomplish their tasks more effectively by making full use of the full set of Microsoft 365 tools. On the other hand, Copilot is also implemented as a chatbot that can communicate with individual users or teams to help them troubleshoot problems and suggest solutions. It is embedded in Microsoft 365 applications such as Word, Excel, PowerPoint, Outlook, and Teams and offers collaboration to all participants in the learning process. To implement these features, Copilot provides personalized access to user profiles and manages personal calendars, emails, chats, documents, meetings, contacts, etc. In addition, it can also be embedded in programming environments such as Visual Studio Code and assist in the teaching of programming in various programming languages in middle school (Puryear & Sprint, 2022).

All this gives reason to the authors to make an assumption that AI can make a significant contribution to improving the learning and teaching process in the classroom.

### 1.3. Approaches to applying AI technologies in the classroom

Despite its potential to revolutionize schooling, achieving positive educational outcomes requires much more than the uncritical use of AI. It is necessary to conduct research and pedagogical experiments to ensure the necessary reliability, validity, and security of the educational process from a didactic point of view. The use of AIED technologies, learning content, and pedagogical approaches must be integrated and adapted to the particularities of the learning environment. Therefore, when designing learning activities supported by AI, teachers should consider six key elements to achieve the expected learning goals: learners, context, tasks, pedagogical approaches, interaction methods, and application of AI technologies (Zheng et al., 2023).

When we talk about the application of AI in school education, we usually refer to various aspects aimed at improving learning, teaching, and administrative processes. Some key areas where AI can be used in education include:

- **Personalized Learning:** AI-driven adaptive learning platforms can analyze students' learning patterns and preferences to tailor educational content and activities to their individual needs. This allows students to learn at their own pace, in a way that suits them best, fill knowledge gaps, and receive individualized learning tasks suitable for their specific status and level.
- **Intelligent Learning Systems:** AI-powered tutoring systems can simulate human interactions in learning, providing appropriate learning resources and offering immediate feedback and assistance to students. These systems can also interact with other participants in the learning process, such as teachers, parents, and administrators, by providing them with suitable services and resources.
- **Testing and Assessment:** AI can automate the assessment process for multiple-choice, true/false, and other normed response questions. This saves teachers' time and allows them to focus on evaluating free-response answers, as well as providing quality feedback.
- **Language Learning:** AI language learning platforms can help students practice speaking, listening, reading, and writing skills in different foreign languages. These platforms often include NLP algorithms for pronunciation and grammar error assessment and correction.
- **Virtual Reality (VR) and Augmented Reality (AR):** AI can be integrated into educational VR and AR applications, enabling students to explore historical sites, conduct virtual scientific experiments, or simulate real-world scenarios. Studies show that this improves understanding of difficult and unclear educational material in subjects like history, geography, biology, etc.
- **Supplementary Knowledge:** AI algorithms can recommend appropriate educational resources, books, and articles based on student's interests, learning progress, and past experiences. This helps students discover new topics and expand their knowledge beyond the curriculum.
- **Preventing Learning Difficulties:** AI can identify potential learning difficulties or challenges at an early stage, allowing teachers to provide the necessary support to students before problems escalate. This aspect of AI application addresses critical important social issues related to students at risk of dropping out.

- ***Special Education and Inclusion:*** AI can be used to develop assistive technologies that support students with special educational needs and disabilities, enabling them to have more effective and inclusive access to education.
- ***Student Support and Counselling:*** AI-powered chatbots or virtual assistants can interact with students and provide advice and guidance related to school issues and other personal emotional challenges, offering additional information, tips, and support.
- ***Administrative Efficiency:*** AI can streamline administrative tasks in schools, such as planning, resource allocation, student enrollment, and staff management. This improves overall operational efficiency and allows teachers to focus primarily on teaching and enhancing the quality of educational activities, freeing them from non-teaching administrative duties.
- ***Assisting Teachers' Work:*** AI can analyze vast amounts of educational data to identify trends, patterns, and insights that can inform teachers' decision-making, curriculum development, and school policy adjustments.
- ***Plagiarism Detection:*** AI-based plagiarism detection tools can assist teachers in identifying cases of plagiarism and cheating, promoting academic integrity among students.

Despite everything presented so far, it is important to note that while AI offers significant benefits to education, it should complement and enhance teacher teaching, rather than replace it entirely. Effective integration of AI into education requires careful consideration of multiple ethical issues and privacy considerations, as well as continuous monitoring, evaluation, and analysis to ensure optimal benefits for students and other participants in the educational process.

## 2. OUR EXPERIENCE

In the last few years, a team of scientists and pedagogical specialists from Plovdiv University "Paisii Hilendarski" in Bulgaria, together with teachers in secondary schools of the Plovdiv region, have developed different approaches for the application of AI in school education in almost all aspects discussed above. A prototype of an intelligent educational platform Virtual Educational Space (VES) was developed as a cyber-physical and social environment that provides adapted learning resources and services to students of various specialties in the Faculty of Mathematics and Informatics (Valkanov, 2016) (Rahnev, 2014). VES is realized as a multi-agent platform, with the personalization of learning realized through the interaction between the personal assistants of all users – students, teachers, and university administration. The VES space provides different types of services such as:

- training and examination tests, analysis of training results;
- standardized SCORM-based learning resources that take into account the individual basic knowledge of each learner and provide an appropriate individual learning path;
- administrative services such as a smart student book and teacher's notebook;
- services for joint work on projects, consultations, etc.;
- provision of services implemented as an integration of the cyber-physical worlds.

As an adaptation of VES for school education, a prototype cyber-physical space called BLISS was developed. This platform is multi-agent and enables personalized learning for self-directed students, as well as personalized access to learning resources and services for regular students. The system was successfully tested during the period of blended learning during the period of COVID'19 pandemic. By using block chain technologies in BLISS, an electronic diary related to the administrative process of issuing documents with factory numbering is modelled and is in the process of prototyping (Todorov et al., 2019). The system for checking and evaluating knowledge is connected to the electronic diary, which monitors the progress of students and, in the presence of educational problems, informs the parents and teachers of the student. In parallel with the development of BLISS, in which the ecosystem of personal assistants is a main component, the team also turned its attention to the integration of AI chatbots, which, on the one hand, can interact with personal assistants and other intelligent agents in the space, and on the other hand, help to solve various tasks in the present classroom training. Over the past two years, with the rapid development of LLM and chatbots, we have been experimentally using the capabilities of AI in the classroom in the following areas:

- for planning the learning topics and lessons by the teachers;
- for personalization of the learning process;

## 2.1. Planning the learning topics and lessons by the teachers

The transition from Education 3.0 to Education 4.0 marks the need to adapt educational systems and practices to dynamically changing technologies. This also determines the need for a change in the planning and preliminary preparation processes of teachers, who turn from expert teachers into mentors and facilitators, and the student from a passive participant in training into an active subject responsible for his own development. This process is a challenge for the teachers' college and requires a new approach to planning learning tasks and learning activities. AI chatbots can be used to a large extent in the planning and pre-training process of teachers. For example, when preparing a Learning and Creativity Plan for the compulsory 6<sup>th</sup> grade school subject "Computer Modelling and IT" lesson with the topic "Drawing in Python", the teacher can make a request to ChatGPT similar to "Create a Learning and Creativity Plan for 6<sup>th</sup> grade on: Drawing in Python. Create objectives, learning tasks, digital competences, teacher and students' activities and lesson process" and to receive the proposition in Figure 1.

As can be seen from Figure 1, the ChatGPT response includes all the desired parts: subjects, grade level, objectives, key digital competencies, lesson flow, teacher activities, student activities, learning tasks, assessment, and additional tips. The proposed plan is not perfect, but it can serve as a good basis for planning the teacher's work and save a lot of his/her time.

Creating a test to test students' knowledge on this topic can also be supported by the chatbot. At the teacher's request "Create a quiz with closed questions to test students' knowledge of this topic", ChatGPT offers the following test (Figure 2).

**Subject: Drawing Shapes in Python**

**Grade Level: 6th Grade**

**Duration: 4-5 sessions, 45 minutes each**

**Objectives:**

- Students will learn the basics of Python programming language and its relevance in drawing shapes.
- Students will understand the concept of coordinates and how to use them to draw shapes on a Cartesian plane.
- Students will practice drawing basic geometric shapes such as squares, rectangles, circles, and triangles using Python code.
- Students will explore creativity by combining and modifying shapes to create more complex patterns and designs.

**Key Digital Competencies:**

- Coding and Programming Skills:** Students will learn the fundamentals of Python programming language to create shapes.
- Computational Thinking:** Students will use problem-solving and logical thinking to visualize and code shapes.
- Creativity and Innovation:** Students will experiment with different shapes and patterns to create original designs.

**Lesson Flow:**

**Session 1: Introduction to Python and Drawing Basics**

**Session 3: Combining Shapes and Creating Patterns**

- Teacher Activity:**
  - Introduce the concept of combining shapes to create patterns and designs.
  - Demonstrate how to use loops and conditions to create repetitive patterns.
- Student Activity:**
  - Create their own patterns by combining and repeating different shapes.
  - Experiment with colors and sizes to enhance their designs.

**Session 4: Sharing and Presenting Creations**

- Teacher Activity:**
  - Encourage students to share their creations with the class.
  - Lead a discussion on different patterns and designs, highlighting creativity and unique approaches.
- Student Activity:**
  - Present their drawings and explain the thought process behind their creations.
  - Provide feedback and appreciation for their peers' work.

**Assessment:**

Figure 1. Created Learning & Creativity Plan

Source: Own work.

**Drawing Shapes in Python Quiz**

**Instructions:**

- This quiz contains 10 multiple-choice questions.
- Choose the best answer for each question.
- Circle the letter corresponding to your chosen answer.
- Calculators and electronic devices are not allowed.
- The total score for this quiz is 10 points.

- What is the primary purpose of using coordinates in drawing shapes in Python?
  - To set the color of the shapes.
  - To change the size of the shapes.
  - To position the shapes on a plane.
  - To add animation to the shapes.

Answer: ....
- Which Python function is commonly used to draw a circle?
  - `draw_circle()`
  - `create_circle()`
  - `circle()`
  - `make_circle()`
- When drawing shapes using Python, the Cartesian plane has how many quadrants?
  - 1
  - 2
  - 3
  - 4

Answer: ....
- What is the correct way to draw a triangle in Python with coordinates A(0, 0), B(50, 0), and C(25, 50)?
  - `draw_triangle(0, 0, 50, 0, 25, 50)`
  - `triangle(0, 0, 50, 0, 25, 50)`
  - `draw_shape(0, 0, 50, 0, 25, 50)`
  - `draw(0, 0); draw(50, 0); draw(25, 50)`

Answer: ....
- Which Python loop allows you to repeat a set of instructions until a condition is met?
  - for loop
  - while loop
  - do-while loop
  - if statement

Answer: ....

6. What does the following Python code snippet do?

```
python
for i in range(4):
    draw_square(100)
```

- Draws four squares with a side length of 100 units each.
- Draws one square with a side length of 400 units.
- Draws a triangle with a side length of 100 units.
- Draws a rectangle with a width of 100 and height of 4 units.

Answer: ....

- Which shape is represented by the coordinates (0, 0), (100, 0), (50, 75) in Python?
  - Square
  - Triangle
  - Circle
  - Rectangle

Answer: ....
- To draw a rectangle with a width of 80 and a height of 50 units in Python, which code snippet is correct?
  - `draw_rectangle(80, 50)`
  - `rectangle(80, 80, 50)`
  - `draw_shape(80, 50)`
  - `draw(80); draw(50)`
- Which Python function can you use to set the color of the shapes you draw?
  - `color()`
  - `set_color()`
  - `shape_color()`
  - `draw_color()`

Answer: ....
- How can you create more complex patterns by combining shapes in Python?
  - By using the `'combine_shapes()'` function.
  - By positioning shapes at random coordinates.
  - By adjusting the size of the shapes.
  - By using loops and conditions to repeat and combine shapes.

Answer: ....

**Scoring:**

- Each correct answer is worth 1 point.
- Calculate the total score out of 10 points.

**Note:** The correct answers to the quiz will depend on the specific concepts and functions taught in the lesson. Make sure the questions align with the content covered and adjust as needed based on the actual materials taught to the students.

Figure 2. Proposed Test for evaluation of students on this topic

Source: Own work.

## 2.2. Personalization of the learning process

Personalization and differentiated approach are particularly important features of modern education. While in the individual work of the students they can interact with their personal assistant or chatbot, in the general or group work in the classroom the teacher looks for other approaches. In pedagogical practice, various forms of typification of students are successfully used, and during his preliminary preparation, the teacher must prepare appropriate learning tasks or training materials for each of these types of students, which are often called Personas. A Persona is a description of a group of students with common characteristics. This description is based on different technologies and determination of different cognitive and emotional types of students (Nielsen et al, 2013). Thus, students in each class may associate themselves with several typical Personas profiles. The differentiated approach and personalization of the learning process is realized in practice by creating appropriate learning content, learning tasks and predicting the behavior of the Persons. Often, Personas can also be seen as typical roles in group work or role playing.

Using ChatGPT let is create typical student Personas according to their cognitive and emotional characteristics. As a result of the request, 5 student Personas were created with their sample names, cognitive and emotional characteristics. Figure 3 shows the Persona Alex.



Create me sample persona profiles of students, according to their cognitive and emotional characteristics



### 1. Persona Profile: Analytical Alex

#### Cognitive Characteristics:

- Alex is a highly analytical student who excels in problem-solving and logical reasoning.
- He enjoys breaking down complex tasks into smaller components to understand them better.
- Alex is attentive to details and often approaches challenges in a systematic manner.
- He prefers learning through structured materials and appreciates clear instructions.

#### Emotional Characteristics:

- Alex is self-motivated and takes pride in his academic achievements.
- He can be critical of himself and strives for perfection in his work.
- Alex is introverted and may need some encouragement to participate actively in group discussions.
- He tends to remain calm under pressure and rarely lets emotions interfere with his studies.

**Figure 3. Created sample student Persona**

Source: Own work.

One of the most important features of modern education is the use of a differentiated approach, where individual students or groups of students go through the learning process in an individual or differentiated way. The created Personas with their char-



acteristics create a prerequisite for the implementation of this approach. We can ask ChatGPT for assistance in creating personalized learning content and learning tasks, according to the cognitive and emotional characteristics of Persona named Alex. Figure 4 shows part of the example tutorial customized for Alex.

**Session 1: Introduction to Python Basics**

**Objective:** Introduce Alex to Python programming fundamentals.

**Teacher Activities:**

Hello Alex! Today, we will begin our journey into the world of Python programming. Python is a powerful language used for various applications, including drawing shapes and creating graphics. Let's get started!

Show Alex a brief presentation on the importance of Python in various fields, including graphics and data visualization.

Explain key Python concepts, such as variables, data types, loops, and conditional statements.

Provide examples of Python code snippets and their respective outputs.

**Student Activities:**

Welcome to the world of Python, Alex! Please listen carefully as we explore the basics of this versatile programming language. Feel free to take notes, and don't hesitate to ask any questions you may have.

**Figure 4. Personalized lesson**

Source: Own work.

### 3. PROBLEMS AND CHALLENGES

Although the use of AI technologies has many advantages, it is essential to carefully examine and soberly assess their limitations, problems, and challenges. We know that popular chatbots can pass the Turing Test, leading users to believe they are communicating with humans rather than bots. This raises ethical concerns related to potential misuse and deception. One of the major concerns is the fact that ChatGPT and other chatbots can spread false and misleading information and enable plagiarism and unethical behavior during exams in schools and universities. In January 2023 the New York City officials blocked access to ChatGPT from the school's devices and networks in the city's 1851 public schools, which serve over 1 million students, due to potential misuse and concerns raised by educators. However, in May 2023 they decided to remove the ban and try to leverage the potential of generative AI to support students and teachers with the understanding the reality that the students are participating in and will work in a world where understanding generative AI is crucial (Rosenblatt, 2023). Privacy and the protection of users' personal information are another significant issue, with Italy being the first EU country to temporary ban ChatGPT in March due to privacy concerns. ChatGPT returned in Italy on April 30

after the OpenAI addressed the concerns of the Italian Data Protection Authority – Garante. These concerns include the necessity of age restrictions, clarifying how data is processed, providing data management options, and allowing users to opt out of their data being used. Other countries, including Canada, Germany, Sweden, and France, opened or consider to open their own investigations into ChatGPT’s practices, including how the training data for the model is collected and what information that model produces for users. This led to further advancement of the AI Act of the European Union (AI Act, 2023) which was first proposed in 2021 and does not fully meet the challenges of the lately emerged generative AI tools and chatbots. These and other ethical problems with the use of AI technologies have led leading experts in artificial intelligence, such as Elon Musk and Steve Wozniak, to sign an open letter warning that uncontrolled AI usage can pose significant risks to society and humanity.

Another key challenge relates to the development and programming of Chatbots. Computational linguistics and Natural Language Processing (NLP) systems present some of the most significant potential issues (Kasneci et al., 2023). The accuracy of a Chatbot in providing information depends on the quality of the input data it is trained on. If not properly regulated and restricted, a Chatbot, for example, trained in chemistry or physics, could provide additional information and instructions on creating an explosive device, posing a threat to human life.

To overcome these challenges, the following eleven ethical principles for artificial intelligence have been outlined: (1) Transparency, (2) Fairness and Honesty, (3) Harmlessness, (4) Accountability, (5) Privacy, (6) Beneficence, (7) Freedom and Autonomy, (8) Trust, (9) Dignity, (10) Sustainability, and (11) Solidarity. These constraints on chatbots must be strictly adhered to, especially when they are used for educational purposes. In general, they raise questions concerning academic integrity and the use of these chatbots for unregulated writing of exam answers. Of course, there are other ethical issues related to the use of chatbots in education, which can be summarized as follows:

- Credibility and accuracy of the information generated and provided.
- Potential biases in the data leading to discriminatory or misleading responses.
- Privacy concerns, as personal information of students and teachers may be stored and used.
- Issues related to the role and skills of teachers and their impact on the job market.
- Lack of interaction with human teachers, which may inevitably reduce the quality of educational and social experiences for students.
- Over-reliance and dependency on technology.
- Concerns regarding intellectual property rights.
- Transparency and accountability, as it may be challenging to identify how the chatbot makes decisions, processes, and analyzes information.

On the other hand, in school education, ensuring fairness and accessibility for all students is of particular importance. It is crucial to ensure that AI-based educational tools are designed with user confidentiality and data security in mind and that they do not exacerbate biases and inequalities (Yang, 2022). Given that versions of Chat-

GPT and Microsoft 365 Copilot can be integrated into Office applications, including Word, Excel, PowerPoint, and Outlook, by using machine learning to analyze data from various sources, including telemetry data and user feedback, it is not difficult to anticipate that the impact of ChatGPT in education will grow rapidly in the coming years. Therefore, additional research is needed to establish the potential benefits and challenges of these emerging technologies for school education.

## CONCLUSION

There are several advantages of using AI in education, as well as certain challenges. AI can improve learning outcomes, productivity, and student engagement by opening new pathways for personalized education, feedback, collaboration and support. However, ethical and practical issues related to the application of AI in education cannot be ignored. Important problems that need to be addressed include the potential for biases in AI algorithms and the requirement for sufficient training and support for teachers.

Collaborative efforts involving teachers, researchers, and policymakers are necessary to ensure the ethical and responsible use of AI in education. We can build a more equitable and successful educational system that provides children with the individualized learning, feedback, and support they need by addressing the challenges posed by AI technologies and leveraging their advantages.

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