APPLICATION OF ARTIFICIAL INTELLIGENCE IN EDUCATION: POTENTIALITIES AND DILEMMAS

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Abstract:

The advent of artificial intelligence (AI) has revolutionised many sectors around the world, even affecting the education sector, offering innovative solutions both for improving learning experiences and for the quality and effectiveness of teaching. Through personalised learning platforms and intelligent tutoring systems, AI has the potential to transform how learners optimally engage with educational content. The present research adopts a critical literature review approach, synthesising recent academic contributions, to identify the main applications of artificial intelligence in education, highlighting both the benefits and the problems that arise and which need a thorough and holistic analysis. Findings indicate that AI applications enhance personalisation, assessment efficiency, and inclusivity, while raising concerns regarding ethics, bias, and data privacy. The study contributes by providing a structured thematic synthesis of benefits and dilemmas, offering professors and policymakers a clearer framework for integrating AI responsibly into educational practice. All these critical issues are of great concern to the education community worldwide, as well as all stakeholders, such as educators, learners, educational institutions, and learning agencies.

Keywords: artificial intelligence, applications of AI, education, potentialities, dilemmas

1. Introduction

Educational technology has drastically changed the way of teaching through the use of educational tools that promote learning and skill acquisition. It is a fact that artificial intelligence has been incorporated into education and is an important teaching tool. More specifically, it is used in the creation of educational content, interactive games, automated scoring, personalised teaching, and improving the quality and effectiveness of learning (Misra *et al.*, 2023).

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The educational process using artificial intelligence can be implemented either face-to-face or online in a virtual environment in order to work individually and efficiently. In addition, artificial intelligence can be used in the administrative tasks of education for the feedback of the trainees (Kottara, 2025a). More specifically, it provides the possibility of storing a large amount of data through an automated process, identifying and collecting the preferences and needs of the trainees in order to create more personalised teaching.

On the other hand, there is concern about artificial intelligence regarding the level of ethics that can be maintained and the protection of personal data of those involved in the educational process (Crawford *et al.*, 2023). Equally important is the question of whether artificial intelligence can replace the human trainer and what he offers. Also, several researchers question whether it can remain unbiased by maintaining an attitude of respect for diversity and abstaining from prejudice when it is based on data with potentially biased content (Kamalov *et al.*, 2023). Education is a cornerstone of human development and progress. With the advent of technology, automated solutions have invaded the field of education, putting human labour under discussion. The comparison between human work and automated solutions in the field of education is a topic that raises many debates (Malik *et al.*, 2023).

Today, professors have the ability to provide tailored support and guidance, offering an educational experience that takes into account the individual needs and capabilities of learners. Human interaction and emotional connection in education are vital to achieving a holistic learning environment for effective learning. The skills of empathy, the creation of a good climate, emotional support and customised teaching, through human interaction, are important factors that cannot be completely replaced by the automated solutions and algorithms offered by artificial intelligence (Judijanto, Atsani and Chadijah, 2024). However, automated solutions can deliver training materials on a large scale at a lower cost, but in several cases, their effectiveness can be limited when it comes to cases of customised learning and individual support of learners. In a broader context, artificial intelligence is important to have a balanced approach that combines the capabilities of technology with human skills to be more effective and qualitative in the field of education (Almasri, 2024).

The contribution of the present scientific study lies in this prism of the above-mentioned issues, while the researcher focuses on and cites an even temporal evolution of artificial intelligence. This study also incorporates a comprehensive historical review of AI, as understanding its philosophical and technological roots provides a critical lens for evaluating its current educational applications. This research is significant, as it addresses the growing need for an updated and balanced understanding of AI in education. Unlike prior reviews that focus predominantly on either opportunities or risks, it provides a comprehensive synthesis of both, offering valuable insights for researchers, professors, and policymakers.

Accordingly, the study poses two research questions that align with the above purposes:

- **RQ 1.** How have the historical and contemporary applications of artificial intelligence contributed to the benefits observed in education?
- **RQ 2:** What potentialities and dilemmas have emerged, both in the past and today, regarding the use of artificial intelligence in education?

This study is structured as follows. In the second section, the literature review is presented; in the third, the methodology; in the fourth, the findings; and in the fifth, the discussion and conclusions. In the sixth, the limitations and suggestions for further research are provided, with the corresponding references listed in the bibliography.

2. Literature Review

2.1 The Historical Review of Artificial Intelligence
The beginnings of artificial intelligence date back to the "reasonings" of Aristotle (384–322 BC), which provided patterns of expressions that always gave correct conclusions from correct premises (Aristotelian reasoning). Aristotle was the first to formulate the laws of human, as well as artificial, intellect and ways of reasoning. Since the mythical age, man has tried to build a machine that would have the ability to think. Hephaestus, according to the myth, built "Talos" as a gift for King Minos. The mythical Talos is the first form of robot in the history of humanity (silver two-drachm of the 3rd century BC). An anthropomorphic giant, with a body of bronze, who, according to Apollodorus, was made by the god Hephaestus to guard Minoan Crete (Kottara and Asonitou, 2024). Artificial Intelligence (AI) is the field of research and applications that aims at the synthesis of intelligent systems, which have the ability to store and process information and continuously improve through learning experience, just like a human (Kottara, 2025a; Kottara, 2025b).

The term "artificial intelligence" was first coined in 1956, at Dartmouth College, USA, at a meeting of researchers from the fields of mathematics, electronics and psychology (John McCarthy, Marvin Minsky, Claude Shannon and Nathaniel Rochester) with the common goal of studying the possibilities of using computers to simulate human intelligence. Then in the following centuries, various philosophers, mathematicians and engineers, with the Arabs being the first to build automatic machines, laid the foundations for robots and computers, which came much later in the 20th century (Guan *et al.*, 2020).

The Engine is perhaps the first reference to an intelligent computer, in Jonathan Swift's famous book "Gulliver's Travels" in 1726. The benchmark book is, of course, Mary Shelley's "Frankenstein" (1816), where the "monster" by Dr Victor Frankenstein may not be a mechanic, but he is still a lifeless automaton that takes life through electricity (Zhai, 2021). In this context, the first philosophical questions regarding the ethics of the "artificial human" are raised. Notably, 1921 marks the inaugural use of the term "robot" during the premiere of the play R.U.R. (Rossum's Universal Robots) by Czech writer Karel Čapek. The narrative unfolds in a factory that produces "humans", referred to as "robots" (Bond *et al.*, 2024). It appears that, beyond Aristotelian "logic", the search for the principles of artificial intelligence led, in 1679, the German philosopher and

mathematician Gottfried Wilhelm Leibniz to formulate the principles of the binary system (0 and 1).

Boolean algebra was founded on this in 1854, when the British mathematician George Boole attempted to investigate the fundamental laws of the mechanisms that govern the intellect in the development of reasoning and to give expression to them in the symbolic language of calculus. Boolean algebra is fundamental to computer science and is the basis for the theoretical study of the field of logical design, and George Boole laid the foundations of propositional logic. In 1837, the mathematician and philosopher Bernard Bolzano developed the central concepts of logic and the concept of logical consistency. It is considered a forerunner of modern symbolic logic and semantics (Udegbe *et al.*, 2024). In 1879, Gottlob Frege proposed a system of automated reasoning and laid the foundations of predicate calculus.

Another important milestone is the three-volume work "Principia Mathematica" (1913) by the British mathematicians Bertrand Russell and Alfred North Whitehead, where an attempt is made to codify all mathematical formulations up to that point through a consistent and complete system of symbolic logic (Wang, 2024). A thorough chronological reference follows in Table 1 regarding the dates of "stations" through the most important events that influenced the development of artificial intelligence. It is clear that its course up to today is of crucial importance and has had rapid development.

Table 1: Important milestones in the evolution of Artificial Intelligence

Timeline	Important Milestones
1943	Warren McCulloch and Walter Pitts propose an artificial neural network modeling algorithm based on mathematics. The Artificial Neural Network (ANN – Artificial Neural Network) is the equivalent of the human brain for robots. It is able to store information, recognize patterns and make associations.
1944	Game Theory, a valuable aid to AI research, was first formulated by mathematician János Lajos Neumann and economist Oskar Morgenstern.
1948	The professor of mathematics at MIT, Norbert Wiener, founded the branch of Cybernetics with the book "Governance or Control and Communication in Animals and Machines?".
1950	Alan Turing, who is considered the father of AI, was inspired by the imitation test (Turing test) for the recognition of intelligent machines and answered with a publication, the question, "Can machines think?" In the article "Computing Machinery and Intelligence" he proposes a test in which a judge should not be able to distinguish whether answers to questions formulated in human language come from a human or a machine.
1950	In the same year, 1950, Claude Elwood Shannon, the father of Information Theory, published his study "Programming a computer for playing chess and described how a computer could be programmed to play chess with a human opponent.
1951	The first working artificial intelligence programs were designed on the University of Manchester's Ferranti Mark 1 computer. A game of checkers and a game of chess.
1954	Developed by Allen Newell, Clief Shaw and Herbert Simon, the IPL (Information Processing Language) language. It is considered the first artificial intelligence language and is based on the theorems contained in the book "Principia Mathematica" by Bertrand Russell and Alfred Whitehead
1956	1956 was the year of the birth of Artificial Intelligence, both as a term and a dynamic field of research, as the 1st Artificial Intelligence Conference was organized for the first time by

	John McCarthy, Marvin Minksy, Claude Shannon and Nathaniel Rochester. This conference, Neural Networks and the Theoretical Study of Intelligence.
1958	John McCarthy develops LISP (List Processing). The second high-level programming language after FORTRAN, it is ideal for research in artificial intelligence.
1963	John McCarthy establishes the first university artificial intelligence laboratory. Stanford's AI Lab.
1964	Joseph Weizenbaum, at MIT's Artificial Intelligence Laboratory, creates 'ELIZA'. The first interactive AI program that can (theoretically) conduct logical dialogues in the English language.
1969	The Shakey robot is being built at Stanford University. The first general-purpose mobile robot that can perceive, analyze and execute simple commands.
1972	Colmerauer and Roussel from the University of Marseille, in collaboration with R. Kowalski from the University of Edinburgh lead to the creation of the logic programming language PROLOG.
1977	Creation of the first empirical systems: DENDRAL (1971), MYCIN (1975), Prospector (1977).
1975	M. Minsky publishes chapters on knowledge representation in books.
1976	Newell & Simon support the hypothesis that a natural symbolic system possesses the necessary features for intelligent actions.
1979	LISP-based computers were developed, after the mid-1970s, by MIT and Xerox. The MIT line also leads to mass production computers, such as the Symbolics 3600/3640/X1200 and TI Explorer. AI application development is starting to become a consumer product.
1982	The first automated fingerprint identification system (AFIS – Automated Fingerprint Identification System), manufactured by NEC, goes into operation.
1987	The first MCL (Macintosh Common Lisp) implementation is completed, turning the Apple Macintosh into a LISP machine
1997	Deep Blue, the IBM supercomputer programmed to play against a human opponent.
2005	65 students, professors and researchers of Stanford University (Stanford Racing Team), create a specially configured VW Touareg equipped with an AI system.
2006	An ambitious project of the Polytechnic of Lausanne, which uses the IBM Blue Gene supercomputer in combination with the NEURON software, through which complex neural networks are modeled. The first phase of creating the first synthetic brain, a copy of the mammalian brain at the molecular level, is complete.
2011	IBM's Watson computer, specially built to answer human questions formulated in natural language.
2017	The article "Attention is all you need" by Ashish Vaswani and other scientists from Google Brain Labs, which introduces the transformer architecture, is published. This architecture consists of multiple layers of neural networks.
2022	Open AI creates chatGPT 3 an artificial intelligence system based on the transformer architecture, which speaks natural language, with knowledge of a wide range of topics, the ability to write scientific or literary text, and the ability to write computer programs in various programming languages.
2023	After the success of ChatGPT, Microsoft has completed the Bing chatbot and the new Edge browser. Google is bringing together the Brain AI team from Google Research and DeepMind to form a new AI-first organization: Google DeepMind. In the same year. Amazon announced its Bedrock platform, giving enterprise customers access to productive AI foundation models and its own Titan models. Meta has rolled out AI updates to its apps and a new AI assistant for WhatsApp, Messenger and Instagram. OpenAI has created the most powerful version of GPT-4 called GPT-4 Turbo and an app store for ChatGPT called 'GPT Store'.

| 2024 | Gemini is the big competitor of Google and GPT-4. |

2.2 Indicative applications of Artificial Intelligence in Education

Based on the literature review, the main applications of artificial intelligence in education are organised into thematic categories for clarity and coherence.

The first category is Personalisation and Instruction, which includes the following applications.

A. Adaptive Learning

Artificial intelligence learning systems give a new role to teachers. More specifically, adaptive learning platforms use algorithms to analyse learner data, helping instructors tailor their instruction based on the individual needs of their class. With adaptive learning, teachers can modify their lesson plan according to the capabilities of their class while also offering targeted feedback.

With the right training, teachers using artificial intelligence can identify both strengths and weaknesses, offering personalised support in order to make full use of each individual's abilities. By enhancing adaptive learning, deeper learning is achieved. In particular, the opportunity is given to connect the knowledge of artificial intelligence with the personal life of the students, and this can help the students to fully understand the course (Napolitano, 2023).

B. Personalised Learning

Personalised learning adapts to the learning preferences, interests and pace of different learners, making the learning process successful for everyone. The AI program adapts the teaching style to the existing knowledge and preferred learning style, always aiming to improve the learning experience for the participants (Asonitou *et al.,* 2020; Kottara and Asonitou, 2025).

C. Intelligent Educational Systems (IES)

Intelligent Educational Systems (IES) have been gradually integrated into teaching and adapting to the capabilities and needs of the learner, while starting from the premise that the field model teaches specialisation in a domain. Then the educational activities influenced by pedagogical models are implemented, and the results are entered into the analysis to determine exactly what they will be. In case feedback is needed, then the system performs the educational activities again, while if the goal has been achieved, then the system is renewed with pedagogical learning models (Şeren and Özcan, 2021).

D. The Virtual Teachers

Online virtual tutors contribute to the acquisition of more knowledge according to the needs of the learners. A typical example is the University of Alberta, which created animated avatars in the form of virtual professors. Through these, they are given the opportunity to display intelligent behaviour and interact with the classes they teach. A virtual teacher is created in a context like a real person would be in order to understand,

solve, and proactively intervene in different learning situations (Kottara and Zaridis, 2024).

E. The Interval Reminder

Peter Wozniak proposed an app that records what people have learnt and when. The application can determine through artificial intelligence the moment when someone is most likely to forget a piece of information and suggest some reminders to repeat this knowledge, which will ensure that the information is stored in the brain for many years (Sanusi, 2024).

The second category is Assessment and Feedback, which includes the following applications:

A. Automated Grading

During the educational process, either towards the end or at more regular intervals, evaluation is very important. This is where artificial intelligence comes in to make it more flexible and faster. More specifically, the automated grader with the application of artificial intelligence is a system that is widely used mainly in universities, reducing the time and complexity of grading.

Intelligent systems could analyse a huge amount of data and provide immediate feedback, making the assessment more qualitative and effective. At the same time, teachers are given the opportunity to better monitor the progress of their students, not only in final exams. The automated scorer instantly evaluates responses and provides feedback, identifying areas that need attention and improvement. This results in the teacher modifying his teaching strategies accordingly to fill the "gaps" in his class and improve their scores. An indicative example is the Moodle platform, which is an important tool in teaching and assessment (Kottara *et al.*, 2025a).

B. The Accurate Reading

In the US 75% use the Newsela platform to learn to read. This platform provides assessment, vocabulary learning and integration of a variety of resources and learners. The reading content is divided into three categories, i.e., libraries (art and culture, science and mathematics, religion and philosophy, politics and economics, etc.), news and text collections. Educational content is presented differently depending on the participants and their reading level. At the same time, teachers monitor student progress through data collection and adjust their teaching accordingly (Sheppard, 2019; Kottara *et al.*, 2025b).

The third category is Communication and Support, which includes the following applications:

A. Chatbots

Chatbots are among the most basic programs used to imitate humans. Artificial intelligence supports many chatbots, especially in education, which allow conversation through text or audio systems and are a digital assistant for learners. They are help systems to solve questions, provide advice on tasks, and create a modern and pleasant

learning environment for all learners at all times. There is real-time interaction, and they enhance communication skills as well as learning outcomes (Gökçearslan *et al.,* 2024).

B. Educational Agents

Educational agents are virtual or digital characters that assist in education and are designed to interact with learners through a real human. They have the ability to appear as a virtual character or avatar and communicate with learners both in writing and orally (Kottara *et al.,* 2025c).

The fourth category is Learning Environments, which includes the following applications:

A. Distance Education

Distance learning, thanks to neural networks and genetic algorithms, offers communication between the distance learning system and the user. In particular, teaching is provided to learners who are not present in a class. At the same time, methods of analysis and evaluation of knowledge and skills are provided, as well as supervision of the distance education process (Asonitou *et al.,* 2020; Kottara, 2025a; Kottara, 2025b).

B. The Smart Classrooms

The "Internet of Things" is the term used to describe the ability of objects to connect to the internet and communicate with other devices. The development of this technology contributes to the creation of "smart classrooms". This classroom to develop needs to have wireless connectivity, personal digital devices, sensors and virtual learning platforms. Inside the classrooms, individual data can be recorded using sensors, which are interpreted in order to improve the ways of teaching and learning (Li and Su, 2020).

C. Inclusive Education

It is an institutional demand around the world that everyone has the right to education, where it is a fact that artificial intelligence promotes inclusive education. AI-supported technologies enable even learners with special needs to overcome difficulties and actively participate in the educational process. Teachers must be fully aware of the specific systems and create a learning environment without limitations and barriers, promoting not only equality but also diversity and inclusion (Kottara *et al.,* 2025d).

D. Virtual Reality

The use of virtual reality in education contributes to the development of imagination with a variety of benefits. In particular, the concept of class expands to the entire world, since it does not stay within the narrow confines of a classroom. In recent years, the companies Google and Facebook have done research on how virtual reality can be applied in education (Li and Su, 2020).

Together, these categories illustrate the main ways in which artificial intelligence is currently applied in education, providing the foundation for analysing its benefits and concerns.

3. Methodology

The researcher focused on the literature review by critically analyzing the existing literature through a systematic way of exploring, criticizing and summarizing the scientific field under consideration, helping to define current knowledge, gaps and future directions.

The methodology followed the principles of a critical literature review, structured and reported in line with PRISMA guidelines. ensuring methodological rigor and reproducibility. All data were collected from reputable scientific databases Google Scholar and Scopus, using the keywords "Artificial Intelligence", "education", "application of Artificial Intelligence", while from the 12.000 studies for the years 2018-2025, the 41 most relevant were selected to identify the relevant sustainable development indicators, performances, challenges and prospects.

The final set of studies was subject to thematic synthesis. Findings were grouped into categories, which are presented in the following sections as potentialities and dilemmas of artificial intelligence in education.

Flow chart 1: PRISMA for studies selection
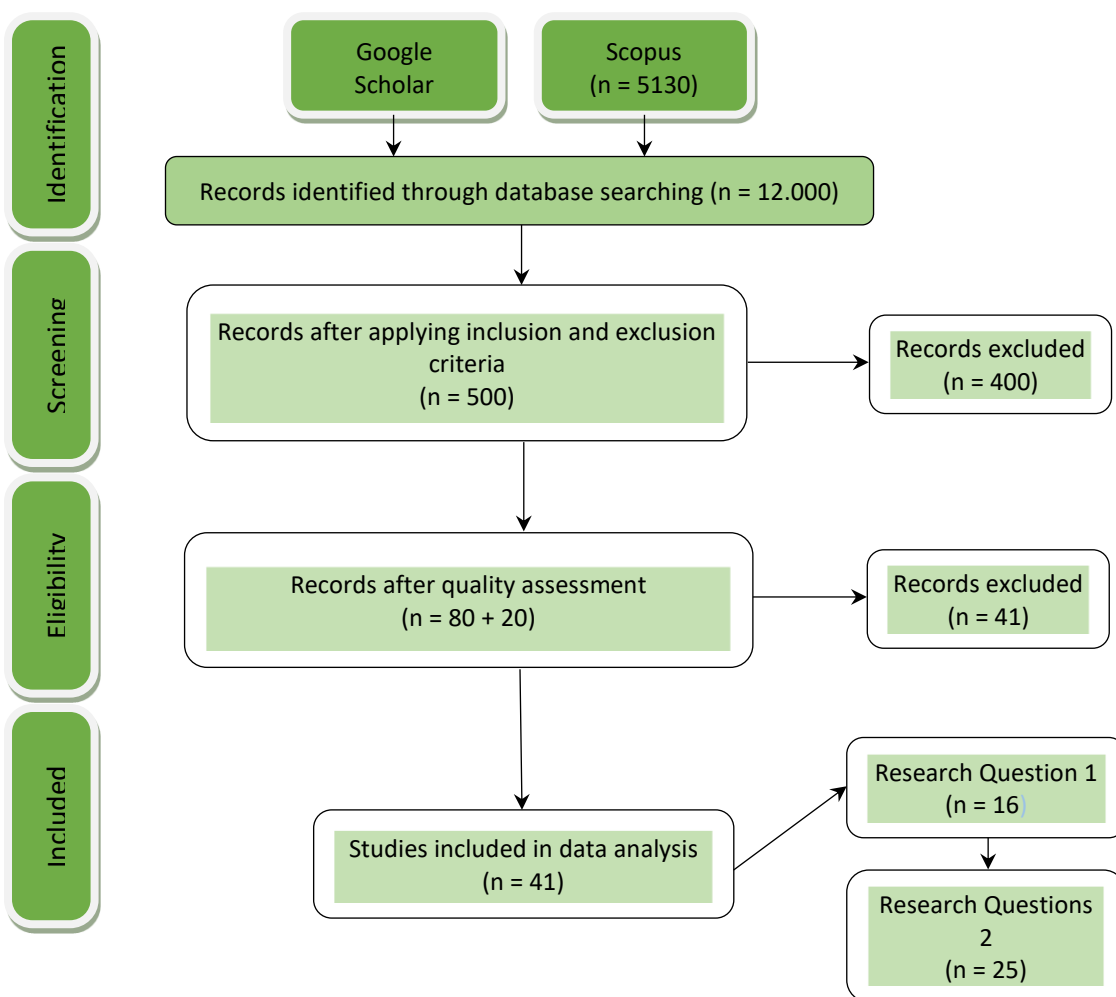
4. Findings

In this section, the most important findings directly related to the present research are listed in detail, starting with the benefits and ending with the concerns when using artificial intelligence in the education sector.

4.1 Applications and Potentialities of Artificial Intelligence in Education

Findings related to the first research question highlight the benefits of artificial intelligence in education, which have gradually evolved over time, from earlier uses of computer-assisted instruction to the advanced adaptive and generative tools of today. For clarity, the identified benefits are presented across four thematic areas, instructional design, assessment, student engagement, and efficiency.

A. Instructional Design & Content Creation

The use of artificial intelligence shows a rapid increase and development, even in areas such as education, exploiting and improving the conditions and effectiveness of educational programs while reducing the cost and time of participants in this process (Bosede *et al.*, 2018). Education has always been based on the transmission of both knowledge and skills. The needs of each society determine the educational goals in order to form citizens of the future. It was found that the synchronisation, therefore, of education with technology is necessary in order to appreciate and recognise the value of the use of artificial intelligence and the possibilities provided through it (Nkambou *et al.*, 2018). The use of artificial intelligence can strengthen both the teacher and the learner depending on the respective level and target location. Professors can produce content for their learners according to their preferences, their desires, and the needs of the class, either as text, or as a video, or as a quiz, or as a presentation. The range of possibilities is limitless, as teachers command the content they want and then receive responses, creating new, more modern educational content, for example, using Chat GPT. In general, the teacher has the possibility to optimise the result by setting improvement parameters (Zemankova, 2019).

B. Assessment and Feedback

In addition, there is the possibility of grading the level of difficulty of the questions or formatting them as open-type, true-false, or multiple-choice. Interactive games, quizzes, and tasks can also be produced to make a lesson more fun and enjoyable, increasing the active participation and learning experience of the learners. The participants can raise personal concerns in order to receive the new knowledge. Notably, there is a great need for personalised education in the new modern educational reality, which can be achieved by the integration of artificial intelligence. The "common line" of teaching, which emphasises a more realistic and experiential approach, is an institutional demand worldwide, as it enables learners to effectively cope with future demands and educational expectations (Di Vaio *et al.*, 2020). Today, it is a fact that the acquisition of knowledge is achieved through games, online videos, and virtual reality that aim to

sensitise the attention of learners and create motivation, giving equal opportunities. Customising the needs of the students during content creation makes teaching more personalised, respecting and adapting to the profile of each participant. The automatic feedback provided makes self-assessment of tasks immediate, enhancing the will for improvement. As students' progress, their preferences, suitable levels of difficulty, and teaching objectives can be investigated to produce the corresponding teaching content. Consequently, learning outcomes show improvement, as motivation to learn is provided and ultimately, students are satisfied (Sadiku *et al.*, 2021).

C. Student Support and Engagement

In addition, the involvement of virtual teachers and educational tools enhances the value of using artificial intelligence. Their constant availability provides the security of finding a correct answer at any time, while reducing the cost that would be required of a worker-trainer in the classroom (Wu *et al.*, 2022). The roles of teachers are reshaped as teachers save time in the production of educational content and preparation of teaching, as well as administrative tasks. Additionally, a framework of automation is seen to a large extent, with course planning and management, as well as data storage, being implemented more by "machines" than by "humans." However, some teachers, particularly older ones, struggle to adapt to the modern digital age and often fail to realise that they make mistakes because of repetitive tasks, which consume time that could be better spent on improving the quality of teaching (Doshi *et al.*, 2023).

D. Efficiency and Learning Outcomes

However, when professors understand the dynamics of artificial intelligence and are willing to become technologically literate through upgraded education systems, it becomes easier for them to offer personalised learning services. It is found in the global education map that the use of artificial intelligence improves the effectiveness and efficiency of teachers and consequently makes the quality of the educational process richer and more improved (Abrokwah-Larbi, 2024). Previous research clearly suggests that artificial intelligence also provides improved learning experiences by adapting and personalising the learning material to the individual's needs (Chen *et al.*, 2020). In addition, it significantly improves lesson preparation time and processing necessary routine actions, while at the same time reducing costs and encouraging students to develop advanced learning outcomes with a high sense of satisfaction, leading to their self-actualisation through their educational path. Overall, the benefits identified reflect a clear historical trajectory. From early adaptive systems and automated grading to the recent integration of virtual teachers and generative AI, artificial intelligence has progressively expanded its role in education, enhancing personalisation, efficiency, and learning outcomes.

4.2 Dilemmas and Limitations of Artificial Intelligence in Education

Findings related to the second research question highlight a series of concerns regarding the use of artificial intelligence in education. These concerns have evolved historically,

from early issues of privacy and data security to more recent debates on ethics and privacy, bias and inclusion, and pedagogy and infrastructure.

A. Ethics and Privacy

Artificial intelligence has raised several debates and reactions regarding the ethical concerns and the security that governs it in terms of the privacy of personal data and the security it provides, or even the possible misuse of personal information (*Bond et al.,* 2024). For this reason, it is important to ensure a framework of responsible and transparent practices, which is of vital importance. In some cases, the implementation of artificial intelligence has raised some ethical issues, as it presupposes the sharing of user data (Crawford *et al.,* 2023). Users, even if they give consent for the use of their data, are not completely sure of its security throughout the process.

B. Bias and Inclusion

In addition, the use of artificial intelligence should prevail in the safeguarding of human rights, integrate and fully accept the protection and acceptance of diversity and therefore be governed by a high sense of inclusion. Bias should stay away from AI. AI systems learn from historical data, and if the data used for training contains biased content, AI can perpetuate it or even exacerbate it (Chassignol *et al.,* 2018). In education, this could lead to inequality of equal opportunities, with negative outcomes, especially for marginalised groups. Transparency is a prerequisite for ensuring human rights in order to respect and defend them (Alqahtani *et al.,* 2020).

C. Pedagogy and Infrastructure

Additionally, it is often observed that AI systems rely on algorithms to provide personalised learning experiences. However, these algorithms may not fully understand the unique needs and learning styles of individual learners, leading to a one-size-fits-all approach. Man, as a social being, learns by participating in a group of people, and despite the technological development and progress in education, it is doubtful that the teacher and what he offers can be replaced by artificial intelligence tools. In some cases, when human contact is lost, communication becomes even more difficult (Dhanda, Kansal and Bedi, 2021). It is very important to cultivate emotional intelligence so that even children can develop the skill of communication as much as they would develop it near a set of people and classmates with whom they will interact in the context of the educational process (Bahroun *et al.,* 2023). However, integrating artificial intelligence into education requires an adequate level of technological infrastructure and training material with the corresponding "intelligent systems and tools". Even today, many educational units do not have access to the necessary devices and high-speed internet, creating a technological gap, leading to the marginalisation of certain groups of participants in the educational process. Resistance also, in the new reality, is a significant obstacle to the understanding and adoption of artificial intelligence in educational practice (Kamalov *et al.,* 2023). Concerns about artificial intelligence in education have evolved over time, beginning

with early debates on privacy and ethics and extending to current discussions on bias, pedagogy, and infrastructure.

Overall, these limitations show how initial worries about data security have expanded into broader dilemmas involving equality, human interaction, and the readiness of educational systems, reflecting a historical trajectory that continues to shape the responsible use of AI in education.

4.3 Overview of Potentialities and Dilemmas of AI in Education

In line with the two research questions, Table 2 summarizes the main potentialities and dilemmas of artificial intelligence in education.

Table 2: Presentation of Findings of Benefits and Problems
from the Integration of Artificial Intelligence in Education

Potentialities	Potentialities	Dilemmas
Automation of routine educational tasks	Freeing up teachers' time, to upgrade and utilize the most complex and creative aspects of education.	- Questioning the role of teachers. - Creating a climate of limiting the teacher's role to the routine educational levels he was already using.
Personalized learning	Adaptation of educational content, oriented to individual needs.	- Reshaping the traditional role of teachers, adapting to the new teaching methodologies with the use of modern technological tools. - Traditional teachers fear for being replaced by educational robots, which are more easily oriented towards the development of personalized learning.
Upgrading education systems	Upgrading the various systems used in education.	- Significant changes in shaping the demand for traditional classroom teaching. - The new jobs are looking for modern teachers who respond to the new educational trends and the upgrading of the educational process.
Assessment tools	Leverage learner performance analytics to holistically deliver valuable insights and insights.	- Moving away from traditional evaluation systems. - The assessment becomes more organized.
Technological literacy of professors	Effective integration of Artificial Intelligence tools into modern teaching methods creates a framework for adaptive learning and personalized education.	Formation of a challenging concept for some professors, especially for those who follow a more centered teaching in their courses.
Creation of new roles of the participants in the educational process	- Curriculum design that integrates AI into the educational process. - Development of the educational technology framework. - Providing support for modern and personalized learning initiatives across the	Significant weakness in the professional development of a portion of teachers who resist the transition to the new normality of the educational process through rapid technological development and the integration of AI, in a context of new roles in learning practice.

	range of educational programmes.	
Ethical issues	- Data evaluation and data protection. - Ease of configuring security valves through the management of the appropriate intelligent systems.	- New responsibilities for those involved in the educational process in terms of managing the limits that must be set in matters of personal data protection.

5. Discussion and Conclusions

The present research explored artificial intelligence by presenting its historical review for a more complete understanding and then focused on its main applications in the field of education, highlighting both the benefits and the concerns. Comparing the existing literature review with the findings of the present study reveals an overall positive result regarding the catalytic role of artificial intelligence, especially in an era rich in innovation. More specifically, it appears that, in the near future, a proliferation of intelligent applications of artificial intelligence will come into significant contact increasingly with human ways, from emotionally intelligent GenAI agents to creative assistants capable of producing high-fidelity digital art. (Guan *et al.,* 2020; Bahroun *et al.,* 2023). The educational community should prepare for the emergence of artificial intelligence systems that are capable of easily navigating complex datasets, offering useful insights with a depth of analysis previously unattainable (Li and Su, 2020; Di Vaio *et al.,* 2020).

At the same time, a conscientious approach to the development of artificial intelligence is presented, with an increased focus on ethical and regulatory frameworks to ensure that artificial intelligence serves the greater good of humanity, enhancing inclusion and positive social impact (Wu *et al.,* 2022). It is an era of unprecedented possibilities, where the symbiosis between humans and artificial intelligence promises to unlock new vistas of opportunity and redefine the educational map regardless of education level and curricula (Abrokwah-Larbi, 2024).

Regarding the second research question, which focuses on the concerns arising from the application of artificial intelligence in the field of education, a human fear of being controlled by machines is identified. In addition, what concerns him is the issue of privacy, in the event that not all ethical measures are observed (Şeren and Özcan, 2021). Another concern is that artificial intelligence can, in some cases, lead to isolation, since learners will not be able to develop interpersonal relationships to a large extent. In this way, the personality development of students, for example, will be negatively affected, and there may be problems of adaptation in the transition to this new perspective brought by the applications of virtual teachers and virtual reality, which may shift to a virtual life and daily practice (Dhanda, Kansal and Bedi, 2021; Kottara and Zaridis, 2024d). In addition, research has shown that when too much attention is given to technology, educational goals are often distorted. In fact, it is emphasised that trainees' skills are acquired in simulation environments and, as a result, cannot be applied in the real world.

Additionally, there is always the risk that the data used to build training models will contain human biases, such as historical data. In addition, the teacher must be trained in new skills that will help them to use artificial intelligence; otherwise, automation may lead to the abolition of natural persons (Kottara *et al.*, 2024e). Of key importance is the finding that artificial intelligence can be implemented in education only if certain conditions are met and security safeguards are provided, with the appropriate logistical infrastructure and legal conditions, such as the safeguarding of personal data. By extension, the application of artificial intelligence in the classroom requires teachers and learners to acclimatise to new technologies and teaching methods. This transition may be challenging for some, but the lack of requisite expertise can be a barrier to effective use of AI educational tools. (Dhanda, Kansal and Bedi, 2021). The use of artificial intelligence in education entails some limitations on creativity and the development of critical thinking.

In conclusion, today educational technology is developing, enriching and making education more qualitative and effective. In the majority of research, it became clear that the use of artificial intelligence brings multiple benefits for all involved in the educational process.

The support of the teacher by automated tasks undertaken by artificial intelligence substantially enhances teaching so that it adapts to the needs of the modern learner. In addition, the time saved enables the teacher to substantially enrich the teaching and reduce the costs of educational institutions and agencies (Kamalov *et al.*, 2023). The use of artificial intelligence in education improves efficiency and effectiveness; consequently, teaching improves. At the same time, there is the possibility for improved learning experiences through the adaptation of the educational material to the needs and abilities of the students. The effects of the use of artificial intelligence in education are evident in the administration, teaching, learning and education sectors. Noteworthy is the fact that automated systems provide financial benefits and reduce the responsibilities of educational staff.

However, artificial intelligence, having a basis of emotional education, makes it difficult to understand and perceive the emotional needs of the trainees. Human relationships and empathy play a very important role in education, but this is where artificial intelligence seems to fall short (Judijanto, Atsani and Chadijah, 2024).

In a broader context, through proper and integrated planning regarding the acceptance and management of these limitations of artificial intelligence in education, the quality, reliability and effectiveness of learning can be ensured. The balanced coexistence of humans and intelligent machines is considered important so that the pedagogical principles and goals of the educational community around the world are not lost.

The present study contributes a novel synthesis by integrating both the potentialities and dilemmas of artificial intelligence in education within a single, thematically organised and historically informed framework. Unlike prior reviews that examined opportunities and risks separately, this study fills the gap of providing a balanced and comprehensive perspective, showing how past developments shape

current debates. In doing so, it offers researchers, professors, and policymakers a clearer foundation for future inquiry and responsible integration of AI in educational practice.

6. Limitations and Suggestions for Future Research

In this scientific work, secondary research was used as the main source of investigation, as an initial basis for approaching the subject. However, it is deemed necessary to carry out primary research at a later stage, which will combine quantitative and qualitative methods, to highlight the new issues and challenges that accompany artificial intelligence. Equally important is the comparison of the results with other research on a more extended level, to identify any differences or to strengthen the scientific findings that already exist.

Today, more than ever, it is necessary to carry out research on critical issues that significantly affect societies, the economy and the environment in the light of sustainability, as the applications of artificial intelligence in education are inextricably linked to this aspect.

Conflict of Interest Statement
The author declares no conflicts of interest.

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