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The Genie in a Bottle: Potential and Major Risks of the Use of Artificial Intelligence in Education

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Abstract

Artificial Intelligence (AI) is an emerging and transformative force in education, offering both significant potential and major risks. On one hand, AI can significantly improve the educational experience by enhancing the accuracy and speed of assessment and grading, personalizing learning experiences, and enabling students to learn at their own pace. However, the integration of AI in education brings with it numerous challenges. AI use in education can perpetuate and exacerbate existing biases, invade student privacy, and result in job loss for educators. There are also ethical concerns surrounding the use of AI and the possibility of AI systems making decisions about students without their knowledge or consent. Given these considerations, the use of AI in education can be seen as a double-edged sword and a strong challenge for educators, policymakers, and technology developers to work together to establish responsible AI practices. Given the little knowledge of this matter within the educational community in general and the panic and concern about the bad applications of the few AI systems that have been released to the public, it is proposed in this article to address these issues on an AI-friendly instead of IA-proof approach and specific educational applications are suggested for the different types of AI that are currently known.

Keywords: Artificial Intelligence, Personalized Learning, Ethical Concerns, Education 4.0, 21st Century Education.

Introduction

Today's world is going through what is known as the fourth industrial revolution, also known as Industry 4.0, which refers to the current trend of automation and data exchange in the manufacturing and service industries [1]. It involves the integration of advanced technologies, such as Artificial Intelligence, the Internet of Things (IoT), and Robotics, into the production process, resulting in significant advancements in efficiency, productivity, and customization [2,3].

This new era of industrialization is characterized by a greater emphasis on digitalization and connectivity, with machines, systems, and people communicating and collaborating in real-time [4]. It has the potential to bring about major changes in the way we live, work, and interact with each other, as well as in the way we produce and consume goods and services. The fourth industrial revolution has the potential to bring about increased productivity, economic growth,

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and improved quality of life for people around the world [5], but it also poses new challenges and requires a new set of skills and capabilities for workers to adapt to these changes [6].

Artificial Intelligence (AI) is a branch of computer science concerned with the development of intelligent computer systems that can perform tasks that typically require human intelligence, such as visual perception, speech recognition, decision-making, and language translation [7]. Artificial Intelligence systems employ algorithms, statistical models, and vast amounts of data to replicate human intelligence, enabling them to process and examine significant amounts of information, discover patterns and correlations, and make predictions and decisions [8]. There are several approaches to AI, including machine learning, deep learning, and natural language processing, among others.

The ultimate objective of Artificial Intelligence is to develop systems that are capable of independently learning and adapting, without the need for explicit programming, and execute various tasks with an intelligence similar to that of humans [9,10].

As time goes by and this topic develops, various types of AI appear, among which the following stand out:

From a lesser to a greater look at the degree of complexity and recognizing that not all authors refer to the different types of AI in the same terms, we first find what is known as “Reactive Machines”. This type of AI is designed to perform specific tasks based on compliance with rules, instructions, or predefined parameters that do not change [11]. An example of a "reactive machine" type of Artificial Intelligence is a chess computer. The AI system is programmed to play chess, analyze the board and make moves based on the current rules of the game, but it cannot remember past games or improve its strategy over time.

A little further up the complexity scale is the AI called “Limited Memory”. As mentioned by Mauá et al.[12] from a hard-technical perspective, this type of AI can remember past interactions, but only for a short period. This allows you to make informed decisions only within the framework of those interactions. An example of a "Limited Memory" type of Artificial Intelligence is a recommendation system used by online shopping websites. The AI system tracks the items that a user has viewed or purchased in the past and uses that information to make recommendations for future purchases.

Later still is the type of AI called “Supervised Learning”. This type of Artificial Intelligence is known as “trained AI” and utilizes a labeled dataset to learn and make predictions about fresh, previously unseen data [13]. An example of a "Supervised Learning" type of Artificial Intelligence is a spam email filter. This kind of system is trained on a labeled dataset of emails, where some emails are labeled as "spam" and others are labeled as "not spam." Based on this labeled training data, the AI system learns to identify the characteristics of spam emails and make predictions about new, unseen emails. When a new email arrives, the AI system uses its training to determine whether the email is likely to be spam or not.

Within a high scale of complexity is the AI denominated as “Unsupervised Learning” In this type, AI is trained using unlabeled data to identify patterns and connections within the data [14]. An example of an "Unsupervised Learning" type of Artificial Intelligence is a customer segmentation system used by a retailer. The AI system evaluates the buying habits of customers and recognizes correlations and trends in the data without any prior understanding of the customer segments. The AI system clusters the customers into different segments based on their similarities in purchasing behavior, without being told which customers belong in which

segments.

In addition to the aforementioned type of AI, there is the so-called “Reinforcement Learning”. In this type, AI gains knowledge through experimentation and correction, being awarded or punished depending on its actions [15]. An example of a "Reinforcement Learning" type of Artificial Intelligence is an AI-powered game agent, such as a computer program that plays chess or video games. The AI system learns how to play the game through trial and error, and receives rewards or penalties based on its actions. The AI system uses these rewards to update its strategy and improve its performance over time.

Further along, reaching the top of the complexity scale is the AI called “Theory of Mind”. Regarding this, Aru et al. [16] indicate that it “is an essential ability of humans to infer the mental states of others”. From this perspective, a “Theory of Mind” type of AI is developed to comprehend human emotions and motivations, resulting in communication that is more similar to that of a human being. An example of a "Theory of Mind" type of Artificial Intelligence is an AI-powered virtual assistant. In this sense, if a user expresses frustration with a task, the AI system may respond with a message of sympathy and offer to assist the user in finding a solution.

And finally, it is worth mentioning the AI called “Self-Aware”: This type of Artificial Intelligence does not exist yet and it is supposed to be characterized by the ability to form an understanding of its consciousness and emotions [17,18].

In this context, education is not immune to the effects of the fourth industrial revolution and in particular, to those related to AI (in all its ways) [19]. Although there are, for the moment, very few concrete educational developments in artificial intelligence that can be found in operation in a broad or generalized way, there are many provocative ideas that are beginning to circulate in educational fields on this matter. In general terms, the vast majority of these ideas revolve around the expectation of transformation of the way students learn [20] and the way educators teach [21].

More particularly, it is suggested that such transformations will have to do with effectively developing our ability to use technology in education will become more personalized, accessible, and efficient, leading to a more effective learning experience for students [22]. For instance, AI algorithms can analyze student performance data, allowing teachers to customize their teaching strategies to better meet individual student needs. For example, AI algorithms should facilitate the analysis of student performance data [23], allowing teachers to customize their teaching strategies to better meet individual student needs [24].

In addition to the above, AI and other 4.0 technologies like Data Analytics or the Internet of Things (IoT), would be aiming to change the way students are evaluated, graded, and given feedback [25]. With the help of AI, assessments could be automated and grading could be done in real-time, making the process faster and more accurate. In that order of ideas, AI-powered learning management systems would be able to provide instant feedback to students [26], allowing them to better understand their strengths and weaknesses and make improvements. In general, the integration of AI in education is being consolidated under a hopeful and positive idea of educational change and innovation, which indicates that we are very close to being able to generate more effective and efficient learning experiences and also increase access to quality education [27].

However, in the relationship between AI and education, not everything is positive and it would be naive not to consider its complexities and risks. Many doubts also arise in this regard, and

that focus on issues related to ethical concerns, teacher job loss, and student privacy [28].

From the point of view of educational research, the use of artificial intelligence in education is an emerging topic of growing interest, as can be seen in figure 1, which shows the magnitude of the scientific production published in peer-reviewed journals on AI and Education.

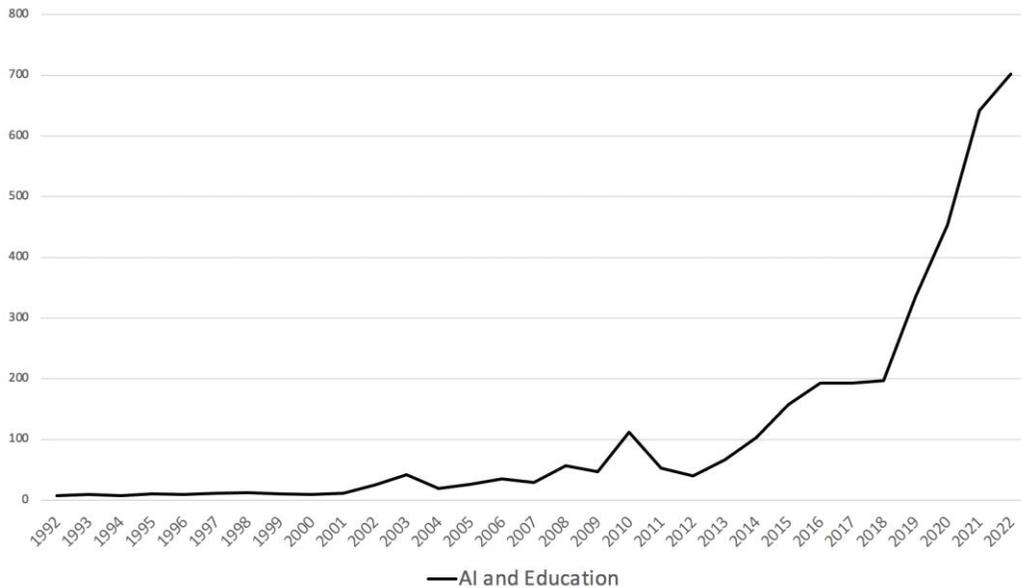


Figure 1: Published peer-reviewed articles on "AI and Education"

Source: Scopus

An issue that should be highlighted from what is presented in this figure is undoubtedly the exponential growth of the research carried out and published on AI and education in the last decade. This is a reflection of the enormous expectations that this topic has generated globally.

Bearing in mind that what has been mentioned so far is arousing great interest in teachers, administrators, and educational policymakers, it is convenient to generate some critical considerations about that, to provide insights both to its potential and its risks, so that sufficient elements of judgment and reflection could be presented to facilitate the work of researchers and developers of AI application projects in education.

Potential of AI in education: please make our work easier!

The potential of AI in education refers to the benefits and opportunities that the integration of artificial intelligence can bring to the educational system. On that matter, the specialized literature highlights three groups of expectations that have in common the focus on the one hand, on facilitating the teacher's work and on the other, on enriching the student's learning experience.

Personalization of Learning: The Key Educational Challenge

By analyzing student data such as learning styles, strengths, weaknesses, and interests, AI can create individualized educational plans [29]. For instance, AI can recommend educational resources suitable for each student, offer real-time feedback on their progress, and suggest

personalized learning goals. This level of personalization enables students to receive an education that is both engaging and effective for their specific needs. Additionally, AI can assist teachers by automating manual tasks, such as grading and assessment, freeing up more time for them to concentrate on other crucial aspects of their role, such as individualized student feedback.

In general, the personalization of learning through the application of AI would be focusing on the construction of what is known as "personal learning paths". Regarding this, Chiappe et al., [30] indicate that a personal learning path is a customized approach to education designed specifically for each student. This approach takes into account the student's individual needs, abilities, weaknesses, and interests, providing a unique and tailored educational experience [31]. In a personal learning path, students should have the autonomy to set their own learning goals and objectives, choose their learning content, and freely move through the curriculum at their own unique pace [32].

The Bright Side of Automation: Free Teachers to Do What They Do Better

In short, what was mentioned in the previous paragraph refers to a concept that has not just gone down well in the field of education: automation. This happens firstly, because teachers are often resistant to changes in the traditional methods of teaching and may view the integration of technology, (as the basis of automation) as a threat to their job security [33,34]. Secondly, there is concern that the automation of teacher-related processes may result in a loss of personal interaction and the weakening of relationships between teachers and students [35]. As a result, this can lead to a reduction in the quality of education and a negative impact on student engagement.

In addition to what is mentioned so far, there are other concerns about the cost and accessibility of the technology needed to support robust AI processes in education. In this sense, not all schools have the resources to invest in the latest technology, which could result in an unequal distribution of resources and a potential widening of the educational and other main gaps between rich and poor schools [36].

Despite the above, a hopeful idea is emerging about this issue, which indicates that automation of some teacher-related tasks through AI can free up time for teachers, allowing them to concentrate on teaching [37]. This should increase focus on improving teaching providing more individualized attention and support and as a consequence, can lead to improved educational outcomes for students [38].

The Tree into the Forest: Moving to A Real Student-Centered Model of Education

Recognizing that the current education system is still industrial, standard-based, and geared toward educating groups of people rather than individuals, all the considerations that have been raised so far about the potential of AI in education seem to indicate that we are facing an imminent era of change or transformation that should begin to drive educational systems towards a mode of operation that is more coherent with what is expected of a 21st-century education [39].

In this regard, AI can provide, collect and analyze large amounts of data related to student performance to support or conduct processes of descriptive, diagnostic, and predictive analytics. According to Farrokhizadeh and Öztayşi [40], descriptive analytics refers to the process of summarizing and organizing data to describe past performance. It provides an overview of what

has happened and answers questions about historical events and patterns. In this type of analytics, AI could help using methods like data mining, data aggregation, and data visualization to present insights related to such data.

Besides, Aqlan et al. [41] indicate that the goal of diagnostic analytics is to determine the causes of past performance or the root cause of an issue. By understanding the underlying causes of a problem or past performance, it should be possible can make informed decisions and take proactive steps to improve future outcomes.

Also, the same authors said that predictive analytics refers to the use of statistical models to predict future outcomes based on historical data. The application of predictive analytics encompasses a wide range, such as projecting student achievement, anticipating future developments in education, and recognizing students who may struggle academically.

As a product of such analytics, the information generated by AI can give teachers and administrators a more comprehensive picture of each student's abilities and performance [42]. This can help them to identify students' strengths and weaknesses, learning patterns, and behaviors, providing data-driven insights and knowledge that can then be used to make informed decisions about educational planning and interventions, allowing for a more personalized and effective approach to education [43].

Major Risks of the Use of Ai In Education: The Other Face of the Coin

Just as many aspects are positive about the use of AI in education, some risks have also been pointed out that must be considered and managed properly so that they do not counteract its positive effects.

Bias and fairness: a careful look is needed

One of the major concerns surrounding the integration of AI into education is the risk of perpetuating and amplifying existing biases [44]. This occurs when AI systems are trained on biased data, leading to biased outcomes and unfair treatment of certain groups of students.

The use of AI in education can lead to the reinforcement of biases based on factors like socioeconomic status, race, and gender [45]. This can result in unequal opportunities and outcomes for students, with certain groups being unfairly impacted. As indicated by Qian [46], furthermore, the use of AI in education can also contribute to the creation of new biases, for example, by reinforcing stereotypes about students based on their performance on certain tasks, so, it's crucial for educators and AI developers to be aware of these biases and take steps to address them.

However, as an ethical issue, there are ways to address bias problems to minimize their possible effects, among which are highlighted:

- Diverse training data. Regarding this, [47] indicate that one way to prevent the reinforcement of existing biases is to ensure that the data used to train AI systems is diverse and represents a wide range of students, rather than just a narrow subset.
- Fairness-enhancing algorithms. The key to this issue is to use algorithms that have been designed to mitigate biases, such as fairness-enhancing algorithms or debiasing algorithms [48].
- Human oversight. Regarding this, Koulu [49] says that including human oversight in the decision-making process, is a proper way to ensure that AI systems are not making decisions

that are biased or unfair. This can be done by having teachers or administrators review AI-generated recommendations before they are implemented.

Job displacement: Is it time for some teachers to step aside?

While some teacher-related tasks may be automated, such as grading assignments, providing feedback to students, and even delivering lessons, there is still a need for human teachers to provide guidance, support, and mentorship to students [5]. However, the extent of the job displacement will depend on the specific tasks that will be automated and the degree to which teachers will be able to adapt or transform their teaching and acquire new skills.

Taking this into consideration, Chen et al. [50] indicate that in some cases, AI may also lead to a reduction in the number of teachers needed in certain subject areas or at certain grade levels, as the technology becomes more advanced and capable of handling a wider range of tasks.

Regarding the above, it is not surprising that AI systems put at risk the jobs of teachers whose main function is to transmit information, and fill the blackboards with the same information that is in the books or free over the Internet to be memorized by their students.

Privacy concerns: the data as a key commodity

There are several privacy concerns associated with the use of AI in education, including:

- Data collection. According to Abrar et al. [51], AI systems often collect large amounts of data about students, including their personal information, academic performance, and behavior patterns. This data can be vulnerable to breaches, leading to privacy violations for students.
- Data sharing. Once collected, student data may be shared with third-party organizations for analysis or other purposes. This can raise concerns about who has access to this data and how it is being used [52].
- Data accuracy. Some researchers such as Aun et al. [53] or Piugie et al. [54] found that AI systems may generate incorrect data or make incorrect assumptions about people, which can lead to privacy violations if this information is shared with others or used to make poorly informed decisions.
- Data misuse. AI systems can be used to monitor students or to make decisions about their education without their knowledge or consent [55]. This “Big Brother” approach can raise privacy concerns, particularly if students are not aware of how their data is being used.

Regarding the above, other authors such as Singh et al.[56] and Zhang and Aslan [57] indicate that it's important for educators and AI developers to be aware of these privacy concerns and take steps to address them. This can be done by using privacy-enhancing technologies, such as encryption or anonymization, and by implementing strong privacy policies that protect the rights of students. Additionally, educators should educate students about the potential privacy risks associated with AI, and empower them to make informed decisions about the use of their data.

Be IA-friendly instead of IA-proof

It is understandable that given the proliferation of news in the press and on TV describing groups of students using AI-based tools and thereby preparing essays or assignments without the slightest cognitive effort, alarm bells go off among teachers and educational policymakers. Such a situation causes, like fire, a sensation of panic and immediate rejection of technologies with

great risks and the same educational potential to spread uncontrollably.

Faced with this type of situation, it becomes necessary to take a clear and committed position to trace a clear path of development and, above all, of transformation in educational practices and processes in schools and universities [58]. Are we for or against it? Perhaps the answer to this is not a discussion of being at either extreme. Perhaps given the complexities that AI is demonstrating, the sensible thing to do is to take a strategic position on the matter.

Being IA-proof would imply trying to completely shield oneself from the influence of AI, which is not only unrealistic but also detrimental to personal and organizational growth and development. Being IA-friendly, on the other hand, involves embracing AI and its potential benefits, while also being aware of its limitations and potential risks. This approach allows individuals and organizations to take advantage of AI's benefits while also being prepared to address its challenges and limitations [59]. In other words, instead of trying to eliminate the bad influences of AI in education, being IA-friendly involves finding a balance between leveraging its benefits and mitigating its drawbacks.

Conclusions

Being AI-friendly, in addition to suggesting an adequate state of mind to face the challenges of using AI in education, means aligning the different components of the ecosystem of educational institutions (teachers, managers, students, technological infrastructure, curriculum, support groups, etc.) in such a way that not only the main application opportunities are identified, but also that the necessary resources are put them into operation in a concrete way.

Given the information discussed in this article, it is now deemed appropriate to highlight some practical and relevant applications for the various types of AI discussed.

In the first instance, the Reactive Machines, due to their particular characteristics, seem especially useful to support and strengthen the simulated training of procedures, for example in medicine or nursing. This applies to the learning of procedures that do not change under variable conditions, context, or time in which they are executed.

The Limited Memory type of AI is especially useful for addressing the complexities of learning styles. It is noteworthy that learning styles do not define a person, that is, a person can show a prevailing style that is related to their best way of learning, however, the styles may vary over time and with the type of task being addressed [60].

Since Limited Memory is a type of AI that remembers past interactions for a short time and can make decisions based on said interactions, it is highly suggestive to think of a learning support system taking into account the record of interactions that can be classified within any of the types of learning styles. Thus, the system would identify the type of current interaction and provide customized feedback and recommendations regarding content or learning activities that are more appropriate to the style of each student. Somehow, the above would indicate the empowering of expert systems through the use of AI [61].

Regarding the type of AI called "Theory of Mind", it is possible to highlight its usefulness for creating personal assistants in charge of monitoring student engagement and keeping motivation levels high during the learning process, especially in modalities with high mediations of digital technologies, where students learn remotely, physically away from their peers and teachers. This is documented by Schiff [62] and Feng and Law [63] as one of the most relevant factors in motivation or engagement problems and its relationship, among other things, with dropout and

low learning outcomes.

On the other hand, the type of AI called “Supervised Learning” seems to become particularly useful for generating feedback systems for learning assessment. In this sense, this type of system received training from a large amount of data coming from the evaluations carried out by the students [64]. In this way, it would be possible to label said data under criteria or categories that the system can identify as relevant to new evaluations and in this way, not only provide feedback on such evaluation but also suggest strategies or contents for the student to reinforce their learning [65].

As said by Besimi et al., [66] the “Unsupervised Learning” type of AI is useful in education to create personal paths by collecting data on students' progress and offering recommendations for the next steps, resources, and goals. Regarding this, the AI system could process the data without pre-existing labels, allowing it to identify patterns and connections in the information to create unique learning paths for each student.

Finally, the type of AI known as "Reinforcement Learning" as it consists of a "trial and error" process could be used as the basis for the design of educational games or educational applications based on gamification. According to Wang et al. [67], by designing educational games that provide instant feedback and rewards or penalties, students are encouraged to learn through trial and error, just like the AI system, which could produce a real-time changing, fun, and dynamic learning environment, increasing students' motivation to participate and engage with the learning contents.

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