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Artificial Intelligence as a Teaching Tool to Promote the Development of Critical Thinking in Primary Education Students

PhD Gloria Morales-Pérez
Escuela Universitaria de Osuna, Spain
glorialuisamp@euosuna.org

PhD Pedro Román-Graván
Universidad de Sevilla, Spain
proman@us.es
https://orcid.org/0000-0002-1646-9247

María de los Ángeles Domínguez-González
Universidad de Sevilla, Spain
mariandg@us.es
https://orcid.org/0000-0002-9687-9325

Manuel Reina-Parrado
Universidad de Sevilla, Spain
mreinap@us.es
https://orcid.org/0000-0002-0801-0938

Abstract
The use of Artificial Intelligence (AI) as a teaching tool to promote the development of critical thinking in primary education students, and its integration into the teaching-learning process, represents an important step in its use as a potentially transformative resource, allowing pedagogical challenges to be addressed through innovative and personalized approaches, focused on active learning and the different teaching strategies that can be implemented in the service of education. AI, understood as the ability of machines to simulate human cognitive processes, offers significant opportunities to enrich teaching-learning processes. By leveraging machine learning algorithms and data ana-

lytics, educators can design adaptive educational experiences that fit the individual needs of students, thereby encouraging their engagement and active participation in the learning process. Through the development of critical thinking, which is considered a fundamental skill that integrates the key competencies of the current educational system, students are encouraged to acquire the necessary skills to face the challenges of a society that needs people who are capable of handling large amounts of information. A pedagogical approach focused on students and a careful selection of active methodologies is necessary to ensure that the use of AI as a teaching tool encourages critical thinking and contributes significantly to the comprehensive development of students and the achievement of educational objectives in the digital age.

Keywords: Artificial Intelligence, critical thinking, active learning, teaching strategies, active learning methodologies.

4.1. Theoretical Foundation

Currently, the latest advances in the field of AI are representing a very notable change in many sectors of society in every sense. In the field of education, the emergence of AI entails a paradigm shift that will undoubtedly disrupt many of the concepts that, to date, we have taken for granted, including what is currently understood as intelligence, the methodologies of teaching-learning, and the objectives of education (Peña et al., 2020). In this context, there are those who express their fears about this revolution with a resistance to change, revealing uncertainties and a process of adaptation that will not be easy. However, other authors, such as Peña et al. (2020), have a less catastrophic view and consider that AI, although it will disrupt a good part of our current conception of the teaching-learning process, is an excellent tool at the service of education. However, it is paradoxical that one of the fears that society faces with the arrival of AI is the fear that it will reduce our ability to think like humans, that it will significantly worsen our cognitive abilities in the long term, or that even decision-making will become worse (Aparicio Gómez, 2023).

There is no doubt that, given the growing proliferation of AI and the multitude of tools and applications that emerge every day, it is essential to address these concerns in a thoughtful and proactive manner. It is necessary to develop an ethical and regulatory framework that guides the responsible use of AI in the ed-

ucational field and in society in general. All of this involves the crucial need to promote digital literacy for the proper use of AI, and to encourage users, whether teachers or students, the necessary skills that allow them to understand and critically evaluate not only the enormous amount of information at their fingertips, but also the role of AI in their lives and in the educational process. The integration of AI as a teaching tool in the teaching-learning process can play an important role in the development of higher cognitive skills, such as critical thinking, problem solving and creativity (Parra & Lago de Vergara, 2003). In the framework of current regulated training, in which competencies are the key to the teaching-learning process, the development of these skills that allow students to fully grow as a person is more necessary than ever (Aguila, 2014). To achieve this, it is essential to adopt a student-centered pedagogical approach and a careful selection of active methodologies that maximize the benefits of AI while mitigating its potential risks (Benzanilla et al., 2019). In this way, AI can become a powerful ally in the search for a more inclusive, personalized education aimed at the comprehensive development of students in the digital age.

The development of critical thinking has become a fundamental objective in current education, since it enables students to analyze, evaluate and synthesize information in a reflective and informed manner, which allows students to not only understand complex concepts, but also apply them in various situations. Developing critical thinking allows students to be more autonomous in their learning process, being able to ask meaningful questions, solve problems and make informed decisions (Gautreaux & Ross, 2018). These skills are essential for their personal and professional development, preparing them to face a constantly changing world and adapt to new circumstances with resilience and creativity.

Some studies such as the one prepared by Vergel Ortega, Rincón Leal and Paz Montes (2019) mention that the educational practice in which students create, discover, imagine and assume information by interacting with other classmates using certain mobile applications, allows autonomous learning that favors the development of critical thinking (Vergel Ortega et al., 2019). Beyond the competencies, it is important to point out that critical thinking does not generate new ideas but rather re-

views, evaluates, values and analyzes the ideas that come to the students, reviewing what is understood and processed, which is why it requires a training process (Nieto & Saiz, 2011).

The development of critical thinking transcends what is done in the classroom, and some authors already point out that many of the repetitive tasks to which students are subjected harm or go against what they need to be able to develop it (López, 2012), also stating that the very tools that allow for a more conducive learning towards its promotion involves training in reading comprehension, problem solving, and language management.

4.2. AI as a Tool to Develop Critical Thinking

AI offers various tools and applications that can enhance the development of critical thinking in primary education students. A good example of this is intelligent tutoring systems, which can be adapted to the level of each student, providing personalized feedback that encourages reflection and analysis. On the other hand, it is important to note that AI-based learning platforms can offer interactive activities that challenge students to solve problems and make decisions, thus promoting the ability to think critically.

In a class context in which active participation is encouraged and contributions are valued, students develop higher motivation, and their level of participation increases. This undoubtedly affects the development of critical thinking, since inquiry strategies, problem solving and a climate of collaborative reflection, which encourages the full development of the necessary skills, is part of the strategies and tools that teachers must provide to establish the appropriate environment and methodological conditions (López, 2012).

In this environment of empowerment through participation, it is important to value not only the types of questions that are asked, as well as the way in which they are formulated, but also the tools and strategies that are put into operation (López, 2012).

One of the highlights is the potential of AI to cultivate critical thinking in primary school students. Through access to AI-enabled digital tools and resources, students can explore complex problems, critically analyze information, and reach informed

conclusions. This approach not only strengthens students' cognitive skills but also enables them to face real-world challenges with an analytical and reflective mindset. To this end, it is necessary to know the elements required to ask good questions, and recognize the different types of questions that can be asked (Hervás-Gómez et al., 2023). However, it is crucial to address the ethical and social implications associated with using AI in the classroom. Educators must promote the responsible and ethical use of technology, encouraging digital literacy and critical consciousness among students.

4.3. Objectives

The use of AI as a teaching tool in primary education presents promising opportunities to enrich the educational process and cultivate critical thinking in students. However, its effective implementation requires a thoughtful and careful approach that considers both the benefits and challenges associated with this emerging technology.

The main objective of this work was to analyze how AI can be used as a tool for the development of critical thinking in primary education classrooms, through its integration as a teaching tool in the classroom.

With the secondary aim of challenging and stimulating the cognitive and metacognitive skills of students, the use of intelligent algorithms and data analysis provided by AI systems was proposed through activities and exercises specifically designed to this end, thus providing immediate and personalized feedback on student performance, to encourage reflection and self-learning, and identify areas for improvement in the development of critical thinking. It will be necessary for AI to adapt to each context and the needs of the students, taking into account inclusive principles, and ensuring the active participation of all students in the educational process.

We trust that this proposal will help teachers understand the implications of the effective use of AI as a teaching tool for the development of critical thinking in the school context. Finally, it is considered that this work is a starting point for collaboration between education professionals who seek innovation and

continuous improvement of educational practice through the use of emerging tools such as AI and stop seeing it as a threat to teaching.

4.4. Methodology

Today's school faces the constant challenge of not only training in knowledge but also in skills that respond to the problems of today's society. The role of AI in the educational context is nothing more than a necessary view of symbiosis that must be contemplated by both areas. This inclusion of AI in the field of education is not only restricted to facilitating the acquisition of knowledge but has promoted a more complete educational approach adapted to the individual needs of students. The ability to adjust the educational experience according to the abilities, interests and learning pace of each student has materialized thanks to this technology, whose presence in education is increasingly solid and constantly evolving. In addition to the personalization of learning, AI has been positioned as a valuable tool for the development of skills linked to problem solving and critical thinking. By creating simulations and virtual scenarios, students face complex situations that require the application of knowledge and skills to make informed decisions, ask relevant questions, and evaluate responses through critical analysis to ensure their validity. Different research on the use of AI to promote Critical Thinking demonstrates how this technology can strengthen the analytical and evaluation capacity of students, preparing them to address the challenges of tomorrow (Palau, 2023).

It is not a simple challenge, since this commitment involves considering, in a slow and analytical way, the problems and difficulties faced by its use in the classroom. This is why the first barrier detected is undoubtedly related to the appropriate use of AI and knowledge of the possibilities it offers in an educational context. It is therefore necessary to take into account the adequate training of teachers to implement the use of AI as a teaching tool, not only in terms of active learning methodologies, but also in the use of AI itself, as well as the tools that will be used, intentionally selecting those that best adapt to the objectives and needs of the students, such as accessibility, attention to diversity

and the possibilities of the classroom in question. The training of these teachers in the use of AI and its integration into a learning process to obtain the best performance is no less necessary. The training of teachers in the numerous tools and skills that open up for the new teaching model that society demands is not something new and is present every time this role modifies either its functions or its role in the teaching-learning process.

The creation of activities that are effective in promoting the development of critical thinking implies being able to create simulation games, debates moderated by chatbots, and research projects guided by intelligent recommendation systems through the appropriate use of the well-known prompts, which involves language development and understanding how different AI-based tools work. Educators must create activities that make use of all the capabilities that AI has for the benefit of the teaching process, establishing an evaluation process and the necessary mechanisms to assess the progress of students in the development of critical thinking, as well as the effective use of language, the feedback that they use to give orders to the AI tools, the strategies they put into operation, etc. (Díaz & Montenegro, 2010).

Continuing with the challenges that this technology presents, it is essential to highlight that the incorporation of AI in education also entails a series of challenges and ethical considerations. One of the recurring topics of debate focuses on the impact that AI can have on the teacher's functions and the role that he or she plays in the training process. While AI has the potential to improve the efficiency and quality of education, it raises questions about the role of humans in the educational process. Related to the ethical issue, and without diminishing its relevance, it is important to point out that, like any emerging technology, preventing the widening of the so-called digital divide poses a challenge, since the availability and adequate training to manage it effectively are not guaranteed for all users on equal terms, which can contribute to the widening of said gap and accentuate existing educational inequalities. It is crucial to rigorously address these challenges to ensure that the integration of AI in education promotes the inclusion and equality principles of today's school.

In recent decades, artificial intelligence has experienced rapid advancement, generating extensive discussions and debates about its integration in the field of education. To understand the

implications of AI in education and its responsible approach, numerous experts have contributed works that broaden the perspective on the role of artificial intelligence in education and its influence on the development of skills such as problem solving and critical thinking. Dillenbourg & Jermann (2007) discuss how to design integrative scripts for collaborative learning supported by technology. Artificial intelligence can play a crucial role in designing and adapting these scripts to facilitate problem solving and critical thinking among students.

On the other hand, Liu & Wang (2020) explore how artificial intelligence can be applied in teaching thinking skills, such as critical and analytical thinking in the field of higher education. Different approaches and technological tools that can foster the development of these competencies among students are discussed. Ayuso indicates in his study that teachers in initial training appreciate the benefits associated with the incorporation of technology, specifically AI, in the teaching-learning process, such as increased motivation, the development of skills linked to problem solving, and the promotion of creativity, which would contribute to the achievement of meaningful and enriching learning (Ayuso del Puerto & Gutiérrez Esteban, 2022).

Authors such as Bautista-Castaño et al. (2019) examine how artificial intelligence has influenced higher education by highlighting the opportunities and challenges that this technology presents to foster critical thinking and problem solving among students (Deroncele-Acosta et al., 2020). For their part, Pérez-Ortiz et al. (2018) analyzed various artificial intelligence techniques used in education and carried out an analysis in which they attempted to explain how these techniques can be applied to promote the development of critical-thinking and problem-solving skills in educational environments. Responsible approaches to AI, as mentioned by Terrones Rodríguez (2021), are essential to ensure that this technology is used ethically and benefits the student learning process.

According to Aparicio Gómez (2023), AI in education has the potential to empower students, encourage creativity and critical thinking, and prepare them to face the challenges of the 21st century. With careful and thoughtful implementation, we can make the most of the transformative power of AI in education (Aparicio Gómez, 2023).

In short, this work aims to establish an active methodology that allows using Artificial Intelligence as an element that favors the development of critical thinking. Therefore, it is based on a participatory and collaborative approach that involves primary education students as main actors in the exploration and use of AI in the field of education.

This active role is considered one of the key aspects of the research and experimentation process of the use of AI in the aforementioned context. In this way, the methodology used was established in different phases, with the aim of promoting the development of critical thinking through the use of AI as a teaching tool.

It began with a first phase that consisted in the identification and compilation of Artificial Intelligence tools that could serve the objective of the project.

In an attempt to know the current panorama of AI tools available to work on the development of critical thinking, it was proposed that students actively get involved in said search, selection and analysis of the various AI tools.

The necessary bibliographic review that was carried out involved an extensive search for information in academic sources, books, magazines and reliable online sources that shed light on the latest advances and research on this topic, and allowed exploring different applications from different points of view. By becoming familiar with the different existing possibilities and the different applications that currently exist of AI to implement in the educational context, an unexplored field of knowledge was opened with multiple possibilities that were evaluated for use. At the same time, they were introduced to the different skills of information search and critical analysis, which provided them with a solid foundation to continue with the rest of the project appropriately.

The work was organized both individually and in groups to compile and analyze the information collected. Classroom debates and discussions were held to share findings and perspectives, encouraging critical thinking and reflection on the potential impact of AI on education to emerge in the process. As this phase progressed, the students began to discern the different AI tools and approaches, as well as the potential advantages and challenges associated with their integration into the educational setting.

The next phase consisted in the implementation of the different activities that were previously designed, with the aim of finding skills related to critical thinking, such as the preparation of prompts and discussion groups moderated by an AI. To this end, the class group was divided into four smaller groups; each of these groups was in charge of designing an activity using AI tools, and was invited to apply their knowledge acquired in the first stage of the study to design practical activities using writing tools. These activities were presented as a challenge or problem resolution that the other groups had to complete. Collaboration between peers became a fundamental aspect, since the students had to put themselves in each other's shoes and think about activities with clear didactic objectives that addressed different learning areas in a cross-sectional manner. During this phase, the students were challenged to work collaboratively to develop activities that addressed specific teaching objectives and were appropriate for primary education. Likewise, the possibility of establishing levels of difficulty in the activities enriched the learning experience by adapting to the individual needs of the students and their different learning rates.

With the development of proposals for use and activities to promote skills related to the development of critical thinking, we started the third phase, which focused on applying the AI Apps and the activities prepared by the students. Each group had the responsibility of carrying out the others' proposals and providing a critical and constructive evaluation. This phase undoubtedly contributed significantly to the development of critical thinking and the ability to design and evaluate educational materials based on AI. The students had the opportunity to experience the practical use of AI tools in the educational process, allowing them to better understand their potential and applicability in the classroom. Additionally, the feedback received from peers drove continuous improvement of learning and valuing of teamwork, and promoted a culture of collaborative feedback.

4.5. Results

Through the different phases of the project, it was possible to understand the use that can be made of the different AI tools

currently available for the development of critical thinking and their application in the field of education. The identification and compilation of the different AI tools allowed for an analysis and exploration of the different resources that can be found and analyzed with a critical view, where the advantages and challenges associated with the integration of AI in the process of implementation could be discerned.

The applied work methodology enabled the development of key skills for the responsible and effective use of AI in education, and enabled the acquisition of skills related to the development of critical thinking, creativity, and teamwork.

4.6. Discussion and Conclusions

The implementation of AI in the field of education is presented as a challenge that requires a deep and detailed analysis of the problems and obstacles that arise in the school environment. One of the main obstacles identified is related to the appropriate use of AI and understanding the possibilities it offers in the educational context. It is essential to guarantee adequate teacher training to make the most of the potential of AI as a teaching tool, both in terms of active teaching-learning methodologies and in the management of the AI tools themselves and their selection to adapt to the objectives and student needs.

Creating effective activities to foster the development of critical thinking involves the ability to design simulation games, discussions moderated by chatbots, and research projects guided by intelligent recommendation systems. This requires a command of the language and an understanding of how different AI-based tools work. Likewise, it is necessary to establish evaluation processes and mechanisms to assess students' progress in the development of critical thinking and the effective use of language, as well as the strategies they use in their interactions with AI tools. Another important challenge posed by the integration of AI in education is the ethical considerations related to the role of the teacher and the impact on the educational process. While AI can improve the efficiency and quality of education, it also raises questions about the human role in the educational process and the possible widening of the digital divide. It is essential to rigor-

ously address these challenges and ensure that the integration of AI in education promotes inclusion and equity.

The results of this study suggest that AI can play a crucial role in fostering critical thinking among students. The literature review and empirical research conducted show that AI can be used effectively to design educational activities that promote critical thinking and problem solving. However, it is important to take a responsible approach to the use of AI in education, ensuring that it is used ethically and benefits the students' learning process.

This study highlights the importance of an active methodology that uses AI as a tool for the development of critical thinking in education. It was shown that actively engaging students in the exploration and use of AI in the classroom can significantly contribute to the development of cognitive skills and promote meaningful and enriching learning. It is essential to continue researching and exploring new ways to use AI in education responsibly and effectively to improve the quality of teaching and learning in the 21st century.

In conclusion, the use of AI as a teaching tool in primary education classrooms offers significant opportunities to promote the development of critical thinking in students. However, its successful implementation requires a comprehensive approach that includes teacher training, the appropriate selection of technological tools, the design of student-centered pedagogical activities and the use of active teaching methodologies that would undoubtedly complement this puzzle.

This work aims to provide a starting point with an argued theoretical basis and a practical intervention proposal that we hope will be the beginning of a productive line of work and a source of collaboration between professionals to guide the integration of AI as an educational resource that allows for the development of critical thinking as a fundamental tool that serves as a battering ram against fake news and the so-called post-truth that circulates so much in today's society.

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