Ensayo científico: La inteligencia artificial en la educación superior

Scientific essay: Artificial intelligence in higher education

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Resumen: El desarrollo de la inteligencia artificial (AI) ha generado gran cantidad de estudios e investigaciones sobre su aplicación en el campo educativo. El artículo analiza los usos y sus resultados, así como los desafíos que presenta y los conflictos que genera. En primer lugar, se explica la historia de la inteligencia artificial, desde su creación, en qué consiste y cómo se está utilizando, para luego profundizar en cómo la educación adopta dichas tecnologías, las incorpora como parte de sus procesos de enseñanza aprendizaje, observando el impacto que provoca en la transformación del aprendizaje. En segundo lugar, se analizan las características del proceso, sus ventajas y desventajas y cómo la utilización de las aplicaciones educativas tiene implicaciones en la reproducción social del conocimiento. Luego, se concluye que, el uso de la tecnología y específicamente la incorporación de la inteligencia artificial en el aula está una disrupción en la educación superior de manera radical, pero aún no se evalúa de manera concluyente el impacto que esto genera en el largo plazo para los sistemas educativos en su conjunto. En síntesis, el artículo busca la comprensión del desarrollo tecnológico, su adaptación en los procesos educativos, especialmente de aquellos vinculados a la inteligencia artificial.

Palabras clave: Inteligencia Artificial, educación, capitalismo, aprendizaje automático, transformación.

Abstract: The rise of artificial intelligence (AI) has sparked extensive research into its applications in the educational sector. This article examines these applications, their outcomes, the challenges they pose, and the conflicts they may generate. Initially, it provides an overview of the history of AI, detailing its inception, fundamental principles, and current uses. It then explores how educational institutions are integrating these technologies into their teaching and learning processes, highlighting the transformative impact on student learning experiences. The article further analyzes the characteristics of this integration, discussing the advantages and disadvantages of AI in education, and how educational technologies influence the social reproduction of knowledge. It is then concluded that the use of technology, and specifically the incorporation of artificial intelligence in the classroom is and specifically, the incorporation of artificial intelligence in

the classroom is a radical disruption in higher education, but the long-term impact of this on the impact that this generates for education systems. Ultimately, the aim is to understand the evolution of AI, its adaptation in educational contexts, and its implications for learning processes.

Keywords: artificial intelligence, education, capitalism, automatic learning, transformation.

Introduction

In the University, there is a novel technological disruption (Ledo et al., 2019) by incorporating the use of artificial intelligence as part of the formative role; the analysis of the mechanisms that underlie these processes is vital to understand as a whole, the transformation of teaching, research, and administrative political management of the University (Gómez et al., 2024). In this article, the relationship is explored between digital transformation that generates the educational restructuring using artificial intelligence.

Methodology

It is a descriptive-interpretative study that combines the analysis of the phenomenon to interpret the results obtained. Its main objective was to understand the problem and analyze the educational experiences in which artificial intelligence is incorporated. It also seeks to understand how higher education is adapted to new technologies, from the educational innovation processes that are carried out. It started from the diagnoses that various studies have made, and we consulted articles that analyze the incorporation of these technologies into educational practice, seeking to understand the new forms of teaching, the application in the use of this technology in the personalization of learning, analyzing the approaches adopted and the results obtained, based on a systematic review. The search and selection of articles and studies was carried out taking as a criterion that they were published in English and Spanish from 2015 onwards and that they are indexed in different databases and repositories of digital journals, taking into account empirical, theoretical studies, and scientific essays that included in their theme artificial intelligence and its use in education at university levels.

The results of the bibliographic review showed the type of artificial intelligence used (Bozkurt, 2023), the educational context in which it is applied, basically referring to the institutional educational model focused on machine learning (Badaro et al., 2013), language processing, and the pace of learning (Chen, Xie, Zou & Hwang, 2020). Artificial intelligence and its educational application have focused its interest in three areas, according to Holmes, these tools can be classified into i) student use, ii) learning processes, iii) various school functions (Holmes & Toumi, 2022). It also addresses the topic of active learning, problem-solving, and advanced chatbot models for distance education that can improve educational quality.

The history of AI

The history of AI is linked to mathematical development and its logical reasoning, whose link with the philosophical reflection of science allowed, together with semiotics and programming, to automate computational languages and unite various artificial systems that gave life to what was then known as "intelligent machines." It can be said that in this creation, there was an interdisciplinary work that involved the combination of different approaches and alternative perspectives to transcend the limits of the disciplines to create a new set of knowledge within an alternative scientific field. Today, artificial intelligence (AI) is an inter- and transdisciplinary field, since it transcends the boundaries of individual disciplines by incorporating a broad vision, with diverse perspectives to address complex problems that require holistic solutions and whose application covers various fields, such as health, engineering, environment, safety, and social sciences. Artificial intelligence has a long history, and its links have been developed by the philosophy of science, whose origin can be located in the 1940s of the last century (Cao, 2023).

The work of Norbert Wiener and Alan Turing laid the initial foundations and is fundamental to understanding the development and evolution of these disciplines. In 1948, Wiener published "Cybernetics, control and communication in the animal and the machine" (Wiener, 1985). The suggestive subtitle of the book illustrates its content. It offers a vision of how complex systems can be interpreted and studied, understanding how to approach self-regulated systems, whose operation is based on feedback, a notion that later allowed to incorporate in engineering, biology and other scientific branches, with the idea that living organisms and machines operate on the same basic principles of human beings that allow them to communicate ideas and interpret processes.

For his part, Alan Turing, computer scientist and cryptographer, wrote an article on computing and intelligence (Leavitt, 2006), an article that later became a reference: "Computing Machinery and Intelligence", whose influence derived in the development of the computer sciences that is now known, mainly by using the concepts of computing and algorithms that defined the meaning of the words "machine" and "think". From this are derived several of the applications that have subsequently been used to analyze the "behavior of intelligent machines" through what became known as the "Turing test," whose consistency allows for evaluating whether or not a machine really has intelligence and is capable of performing certain tasks. Turing asked himself the question "Can machines think?", and his answer became a test to evaluate the intelligence of machines. He did it using the criterion of imitation, looking for the machine to perform behaviors similar to a human being, which, through logical reasoning, can be concluded. One of the main contributions of Turing's work was the birth of natural language processing, one of the many disciplinary variants in which he derived computer science, where Noam Chomsky contributed with the grammatical forms used by computational languages (Ramos J., 1993).

It was John McCarthy who coined the term artificial intelligence. He used and explained this concept at the Summer Research Project on Artificial Intelligence in Dartmouth, conducted by the University of Dartmouth, United States, in 1956. Among his main conclusions was the need to achieve an interdisciplinary approach through collaboration with experts from various scientific disciplines, to have the possibility of creating machines capable of carrying out their own learning and solving problems using language to expose their results. Its key concepts were the representation of knowledge using formal logic in the heuristic search for content. He did it through the LISP programming language that he designed for this purpose.

What is Artificial Intelligence? With the passage of time, the concept of artificial intelligence used daily to describe technologies that use learning algorithms has become widespread, but with varied interpretations when relating this concept to other scientific disciplines, such as artificial intelligence applied in education. The Dartmounth Conference defined artificial intelligence as making a machine behave humanly (McCarthy et al., 2006). The currently most used concept describes it as a scientific discipline in charge of building intelligent "machines" (Norvig & Russell, 2002). Artificial intelligence tries to simulate and build intelligence capabilities by imitating how the human brain works (Badaro et al., 2013).

A general definition could include those processes that simulate learning and its reasoning, acting according to a combination of algorithms that allow for imitating human abilities to make decisions and solve problems, also as those cognitive activities performed by computers (Chen, Xie, Zou & Hwang, 2020). A scientific definition includes the ability of the system to imitate and replicate intelligent behaviors, improving its performance through user experience and adaptation to real and concrete situations that present themselves to it (Norvig & Russell, 2002). There are two ways to classify them. A so-called weak intelligence that works in limited contexts, such as Google's search engine, Amazon's Alexa assistant, or Apple's image recognition. Strong or general artificial intelligence can solve any problem, without that meaning that its answers or solutions are true. What the algorithm does is learn, update, and respond logically to any environment, with its built-in failures and errors.

Artificial Intelligence is a field of computer science that develops autonomous tasks based on human intelligence, which include learning, reasoning, perception, language processing and decision-making. They are machine-based systems that have a certain set of objectives (Naidoo, 2024), according to the program and its algorithms on which it is designed. AI is based on a variety of techniques and subfields that include machine learning, artificial neural networks, language processing, and robotics.

The singularity of artificial intelligence refers to the fact that, in a certain time and space, human intelligence will be surpassed by the development of intelligent machines. It is a philosophical concept that predicts the fusion of intelligences (Kurzweil, 2005). Various institutions work on this concept to predict the impact and suggest adaptability, thereby generating a scenario of uncertainty, mainly around employment, social inequality, and the loss of security, both existential and ethical.

Education and the development of artificial intelligence

In education, artificial intelligence adapts learning environments and customizes them to develop strategies with users and takes advantage of constructivist logic, where people build their own knowledge through structured mental schemes to achieve the assimilation of new processes with concrete experiences that allow learning and obtain as a result, cognition (Rosenthal & Zimmerman, 1978), which refers to a series of mental works that relate activities, symbols and logics. Artificial intelligence builds those models from data, something similar to what Piaget calls mental schemes, while deep learning of computational models follows the assimilation scheme. Personalized learning is one of the pillars of constructivism and converges with the adaptation of artificial intelligence.

Using Peirce's epistemology to solve the deduction and induction problems generated by mental processes, an attempt is made to incorporate artificial intelligence into the programming code. It can be mentioned that this generates two problems, one of knowledge and the other of relevance (Larson, 2002), and in that confusion Peirce's answer is the use of abductive logic, which includes programming logic, the assimilation of knowledge and the processing of natural language (Aliseda, 1998), whose reasoning is the product of these three logical schemes of integration. Adaptive learning implies an accurate adjustment of the contents based on the response provided by users. Artificial intelligence can learn from that data to, without the need to have a programming code, analyze the information and generate a response. This can be a stimulus, a question mark, or a recommended pattern to deepen learning.

In this presentation of Peirce's logic, it is clear that before "intelligent" machines can teach, they must learn, and those who teach machines to contextualize reality, they are the same questions and answers that they provide, linked to the databases that you can explore, plus the programming codes of which the application is composed. In essence, the machine learns to make inferences, take references in an inductive and deductive way, but without distinguishing the context, nor the relevance, nor the human deduction that which the problem is accompanied by (Larson, 2002). The abduction of Peirce is the most creative way they have found to generate an inference that allows the incorporation of a hypothesis in the contextual frame of reference on which the initial question is asked.

Machine learning uses uncertainty to create a hypothesis or to find a logical explanation, based on previously entered parameters. That leads us to the issue of explanatory intelligence and artificial creativity, a capacity from which new ideas arise, and which they have called regenerative intelligence. Human learning involves structuring, organizing, and processing information and context. Artificial intelligence looks for patterns in the data to obtain answers and suggest predictions depending on the type of information requested and the number of processes that are carried out. To achieve this, feedback is necessary, since programs already have a set of data whose complexity and size are difficult to visualize for humans, but not for machines that also handle logical deduction and the appropriate inference to process the requests for information that are requested. However, to offer forecasts, predictions, trends, patterns, behaviors, and interpret theories, decipher authors, and analyze contexts, they have to understand the language from which the request for information starts.

Machine learning uses techniques to analyze data and, from there, make predictions, which is why it is said that it learns from data, its patterns, and its distributions. Deep learning is inspired by how brain neurons work, but always used to process data, to identify the connections that exist in complex data patterns. The novelty is when these mechanisms can understand and interpret the data, and from that share the results through language, a mechanism from which they can generate a representation of the knowledge that is extracted from the patterns and links that they analyze. At this point, controversy arises when the analysis of biases is included, which serves to understand the construction framework of artificial intelligence and the effect it has. And this has to do with Habermas' proposal for communicative action (Berlanga, 2023), taking into account that communication between human beings seeks understanding based on the validity of the statements, recognizing the biases that exist, such as sincerity, ethics, and the perception that people have of a certain subject. Therefore, Habermas offers a frame of reference to address the communicative biases that artificial intelligence may have.

In the Turing Test, it is proposed that a machine or program that can understand natural language is proof that it has intelligence similar to humans. Other tests, which have been developed over the years, seek to understand the context (Larson, 2002), to expand the scope of the interpretation of what has been requested, but various studies carried out to analyze, for example, the reading comprehension of some artificial intelligence applications do not pass the test (Larson, 2002). Here, the cognitive philosophy merges with the phenomenological aspects of intelligent processes that result in information-based thinking models, based on the mechanical concepts of systems theory (Wiener, 1985), which leads us to raise that artificial

intelligence in the end ends up identifying with a theory, and therefore, adopts an ideology (Morador, 2003), but as the artificial processes of computational intelligence are simulated, in the sense of comparison with human thought, it turns out that regenerative learning will not be able to assume and develop the same path of human learning, or as Bower (1975) proposes that machines think, does not mean that they do it the same as human beings, however, artificial intelligence can change the way we think and act (Chen, Xie & Hwang, 2020).

In the end, who shapes regenerative intelligence is the "language", giving meaning to the structure of knowledge, the meaning, the form, and the power that is achieved through linguistics to structure abstract thought, which materializes in language (Giannini, 2023). Therefore, it is essential to understand this type of technology and the role it will play in all educational areas. Faced with this reality, UNESCO prepared a guide that recommends being applied in each school, based on the use that will be given to artificial intelligence within the school system, which represents a valid concern when talking about the uniqueness of this technology that transcends life itself (Futurism, 2018), in the face of the challenge of future education to the present generation.

Impact of Artificial Intelligence on education

Various studies address the impact that artificial intelligence is having on education (Salinas, 2024; Carvajal et al., 2024; Chen, Xie, Hwang, 2020), and the way in which it is learned and taught using these tools; either through the personalization of learning (Castillo, 2023), the automation of tasks or meaningful learning (Granados et al., 2017), using technological tools of artificial intelligence or using the existing digital educational platforms in the market, thus causing a transformation of teacher roles, curricula, management and Their educational models. These processes can mean a change of era that, in the future, will affect humanity as a whole, since their scope is still uncertain.

According to experts and various articles consulted, the use of artificial intelligence in the educational system can improve student performance (Fajardo Aguilar et al., 2023), optimize learning experiences (Bozkurt, 2023), change, in terms of effectiveness, the development of skills (Usart Rodríguez, 2023), and in general it is a tool that allows to improve the teaching process, learning (Romero, 2024), including the improvement in research processes (Cotrina- Aliaga et al., 2021; Delgado de Frutos et al., 2023).

One of the most innovative developments using artificial intelligence is the so-called adaptive learning, whose model is based on the incorporation of a computer with artificial intelligence in the learning processes. It can be said that it is a tool, but not like any other. Rather, it is an instrument that allows the student, and also the teacher, to follow the established objectives, combining what they call blended learning with e-learning that is developed on virtual platforms and seeks to personalize learning (Ramos O., 2024).

Empirical evidence was also found on the existence of positive impacts around the role of the teacher and the pedagogical strategies used with digital environments (Wiliams & Beam, 2019). According to the evaluations of the Harvard Project and Australian Science Education Project, there were improvements in student results (Fraser, 2023) by using digital environments and educational platforms to overcome the crisis caused by COVID-19. Other studies come to the concussion that the incorporation of artificial intelligence improves academic performance and student experience by personalizing teaching and learning (González et al., 2024), while "depersonalizing" teaching (Botero Quiceno, 2024); for teachers, greater uncertainties are created (Jacovkis et al., 2024), and cause a disruption of the educational system (García-Peñalvo, 2023).

On the use of artificial intelligence, specifically ChatGPT, in educational environments, it is considered to have a positive impact (Zhai, 2022), but other studies state that its use is accompanied by a new teaching philosophy (Tlili et al., 2023). GPT (Generative Pretrained Transformer) models allow us to understand contexts, meanings, and nuances in sentences and respond by imitating the structure of human language. Studies were identified that show that the artificial intelligence tools with the greatest potential, used in the classroom, have their psychological origin (Orozco-Malo & Silva-Amino, 2023), but despite this, there are also difficulties in linking the technological with the pedagogical (Jacovkis et al., 2024). All studies explain how artificial intelligence tools are assimilated and learned in the daily learning processes. Currently, some universities have focused on changing skills to improve learning analytics (Garmpis et al., 2022), which may have direct implications for new knowledge, skills, and values that translate into new orientations in study programs.

Educational robotics is analyzed as a tool that can model learning (Moreno Padilla, 2019) through the personalization of learning trajectories. Artificial intelligence systems trace personalized routes to create unique learning guides, based on the experience, uses, and interests of students, proposing exercises and detailed explanations on specific topics that reinforce the students' learning needs. Within the framework of constructivism, robotics can offer the possibility that students build their own knowledge (Requena, 2008), which can help the development of computational thinking in students (Resnick et al., 2009).

The cognitive models used by intelligent tutoring are oriented to directed practices, oriented evaluations, and distance education. The application of computer-assisted evaluation programs seeks to generate, in addition to automatic appreciation, real-time feedback, using various natural language processing techniques (Rodríguez & Oliveira, 2014). On that basis, it is intended to build and measure efficiency in student performance through personalized feedback.

How does education change, and what meaning does it adopt

The educational agenda is currently marked by a digital transformation that is part of the so-called digital capitalism. Companies have ventured into the education market, taking advantage of the disruption caused by the Covid-19 pandemic to generate from there, a new education, based on the fifth wave of educational reforms (Reimers, 2021) that has to do with digital gaps, social challenges, and existing innovation potential. This educational transformation goes hand in hand with the digital business transformation (Teng et al., 2024), which reconfigures a new reality called education 4.0, which is no more than the integration of technology into teaching-learning processes.

For some, this transformation is a school of thought (Vázquez et al., 2022) that includes specific skills, emotional and permanent education; for others it is an integrated education with artificial intelligence systems that manages to transform traditional approaches (Delgado et al., 2023), where learning is done through personalized data (Pérez-Romero et al., 2020) and has a diversity of applications, such as project-based learning through online platforms, educational applications, virtual reality and automated experiences where the student is the direct protagonist of the learning process.

In all cases, the role of the teacher is reduced, in some cases replaced by computer programs, which answer questions, resolve doubts, and, in more advanced processes, they can interact online; these are called "chatbots" or digital tutors, which are the applications that maintain the conversation through a system.

All this, as a whole, is generating important changes in educational orientation, mainly linked to the needs of industry 4.0 and its professional training (Vázquez et al., 2022), whose trend is concretized and widespread in cyberspace. These processes strengthen educational innovation based on digital devices, generating a very particular pedagogical integration (Carbonell-García et al., 2023). The skills of "being", "knowing", and "doing", which materialize the motivations for learning, which are mainly oriented to professional training as a job opportunity (Lordon, 2015), are readjusted to existing needs, contexts, and technological development.

Productivist paradigms are closely linked to the primary vision of human capital, which developed at the dawn of neoliberalism, as well as new cognitive abilities are linked mainly to problem solving and not to the development of knowledge.

At the conceptual level, the competition approach focuses on a utilitarian teaching determined by skills and abilities whose main functionality is the development of behaviorist actions that give it suitable conditions for the sense of training for educational activity. Therefore, educational policies, as instruments that allow the coherence of the entire system, become guides for action and concretization of "know-how", in the essence of which the change of approach is found.

Artificial intelligence directly affects work by automating certain jobs where such technology can be applied, while improving productivity in those where its use can be expanded. The school is called to promote skills related to the use of artificial intelligence, not only for adaptability to change, but also, and much more importantly, for the employability of future workers (Gomez et al., 2024). This adaptability is important, taking into account the speed of the pace that technology evolves. Education must solve the technical complexity of its creation, but, above all, its application in the different spheres.

Personalized learning is linked to distance education, the development of virtual learning environments, and the design of learning tools using artificial intelligence. These processes are based on the analysis of data about the students, their interests, and study patterns, and on that data, the learning journey is built in a personalized way, creating exit profiles for each of the students, giving importance to the weaknesses and strengths that the data previously analyzed throws. The question that arises in these processes is whether you can manage the needs of students based on data from their school history. The educational platforms collect the results of previous evaluations, the exercises, tasks, and problems that have been carried out, and present learning alternatives for students based on adjusting the pace of learning, the contents, and the degree of difficulty they may have. The integration of artificial intelligence to platforms such as Google Classroom, Microsoft Teams, or Moodle requires the construction of educational resources previously. The most used are Dall-E and Midjourney for creating images, Genially for creating interactive content, among others. In summary, artificial intelligence generates the learning path; the teacher must integrate those elements using other tools and then establish the link with digital platforms.

From the pedagogical perspective, what the teacher receives from digital intelligence is the prediction of the possible needs of the student, and on that basis, he builds the process to achieve the learning objectives. According to some authors, this is how effective learning is promoted (Ramírez, 2024). Artificial intelligence allows you to automate tasks and adapt the content based on the personalized journey that was previously proposed, and then the teacher must adapt that to the virtual learning environments.

Conclussions

During the analysis carried out, it was possible to verify that there is an educational transformation underway and that it is caused in part by the use of artificial intelligence. The use of this technology has spread in various ways, in some cases with their own developments, in others through adaptation processes for specific contexts, but which result in a radical change that is deeper than what has initially been considered.

The literature review made it possible to know the existence of different educational dimensions where artificial intelligence is used. Studies on how to cultivate equitable learning environments, to analyze the performance and empowerment of technology by integrating racial stereotypes, can generate a vision of concern about some factors that are present and reinforce educational problems, especially with regard to the digital gaps it causes. The recommendation is to deepen the existing data and carry out local research to reinforce the results of the evaluations carried out so far.

It is pertinent to conclude that no evidence could be found that can be generalized, nor an evaluation that includes the multiple variables that allow describing the complexity generated by the use of this technology in educational environments. The improvement in student learning and performance was only observed in the analyzed studies. One of them recommends analyzing quantitative and qualitative data on the results obtained on performance (Alalawi et al., 2024). However, no evidence was found to determine standards that can generalize the empirical results of the studies and articles analyzed. Nor have indicators been built that allow the inclusion of the complexity of factors that affect student performance, which allows us to conclude that it is artificial intelligence that contributes to these results.

The potential for success of artificial intelligence depends on the tools used, the way they are applied, the way the institution adapts them, and the context in which they are going to be used. In any case, the main factor remains the training of the teacher and his knowledge of these technologies. The studies make it possible to identify positive factors in the use, but important challenges in its expansion, which have to do with teaching skills according to those learning skills in the use of these mechanisms. In the end, the impacts, whether positive or negative, will be seen in the long term. But it will have to be taken into account that these developments have grown very quickly.

In countries like Guatemala, there is an access barrier that limits the application of Artificial Intelligence, caused by the so-called digital divide, which manifests itself in the inequality of access to devices, the cost of internet connectivity, and the use of the software necessary to take advantage of the available artificial intelligence tools. This generates a gap in learning opportunities and digital skills development. Also, the resistance in some institutions and among teachers to adopt these new technologies, an adaptation that also directly affects students in unfavorable socioeconomic conditions. In the absence of public policies that address the social, economic, cultural, and educational gaps that exist, the incorporation of new educational technologies will continue to be unequal, which constitutes a brake on the full development of the capacities that may exist.

Finally, social gaps are reinforced with digital gaps, and patterns of technological dependence expand.

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