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The Impacts of Artificial Intelligence on Personalized Learning in Distance Education Courses in Brasil

Os Impactos da Inteligência Artificial na Personalização do Ensino em Cursos de Educação a Distância no Brasil

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Abstract

The study investigates how Artificial Intelligence can personalize teaching in Distance Education courses in Brazilian higher education, ensuring educational quality and addressing students' individual needs. The qualitative research incorporates neuroscience principles, theories of personalized learning, and the use of the Research Rabbit tool to expand references. It also analyzes government documents and news reports on the regulation and impacts of Distance Education in Brazil. The results indicate that AI has great potential to individualize teaching and enhance educational efficiency, but it requires ethical implementation, data protection policies, and ongoing professional training. It concludes that AI is a promising tool for Distance Education, provided it is supported by clear regulations and responsible practices.

Keywords: Distance education. Artificial Intelligence. Personalization. Neuroscience.

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Resumo

O estudo investiga como a Inteligência Artificial pode personalizar o ensino em cursos de Educação a Distância no ensino superior brasileiro, assegurando qualidade educacional e atendendo às necessidades individuais dos alunos. A pesquisa, de abordagem qualitativa, inclui fundamentos da neurociência, teóricos da personalização do ensino, e o uso da ferramenta Research Rabbit para ampliação das referências. Também analisa documentos governamentais e noticiários sobre regulamentação e impactos da EaD no Brasil. Os resultados mostram que a IA tem grande potencial para individualizar o ensino e aumentar a eficiência educacional, mas requer implementação ética, políticas de proteção de dados e formação continuada dos profissionais. Conclui-se que a IA é uma ferramenta promissora para a EaD, desde que apoiada por regulamentações claras e práticas responsáveis practices.

Keywords: *Educação a distância. Inteligência Artificial. Personalização. Neurociência.*

1. Introduction

The current Higher Education Census, from 2023, released in 2024 by the Ministry of Education (MEC), showed that the pace of opening new Distance Learning (EaD) courses in Brazil rose since 2018 and varied by 232%. This growth, which has been observed for decades, accelerated with the pandemic and technological advances. Another determining factor was the relaxation of rules, starting in 2016, for the offering of distance learning courses by the MEC and the National Education Council (CNE) (Dourado; Moraes; Siqueira, 2024).

The figures revealed that this type of education has become established, but they also raised concerns about educational quality. The 2022 ENADE – National Student Performance Exam – highlighted the figures: one-third of courses had below-average scores, only 3.7% achieved the maximum score (5), and 33.7% received scores of 1 and 2, the lowest possible.

When the Ministry of Education presented the results of the 2022 Census in 2023, it signaled the need for greater regulation. In June 2024, through Ordinance No. 528, it suspended the creation of distance learning courses until March 2025 and began reviewing the regulatory framework.

Authors Fialho, Barros, and Rangel (2019) discussed the relationship between the current regulatory framework for distance learning courses and the essential requirements for pedagogical quality in courses, concluding that any distance learning model based on pedagogical quality is not covered by the regulations. They pointed out the possible existence of an objective conflict between the model with pedagogical commitments and the course model for large numbers of students, designed for low interactivity and customization.

This shows that it is not enough to simply democratize access to education; it is necessary to invest in skills development by improving the teaching and learning process (Paula; Ferneda; Campos Filho, 2004). Nowadays, it is unusual to discuss this topic without addressing the personalization of activities. With advances in some areas, such as medicine and neuroscience, more information has become available on

some issues that arise in the classroom. These discoveries have also reached society more quickly thanks to the advancement of the internet.

This context facilitates more diagnoses, but other factors also influence the increase in these rates, such as policies of medicalization of life. In 2012, the Federal Council of Psychology launched the campaign "No to the medicalization of life," warning that social, political, and cultural issues are being treated as 'disorders' or "disturbances," often under the influence of the pharmaceutical industry. As an example, the CDC (2023) revealed that in the US in 2000, there was one case of autism for every 150 children; in 2020, that number rose to one in 36. Also in 2023, the Brazilian Ministry of Health pointed out that ADHD affects between 5% and 8% of the world's population.

On the other hand, neuroscience allows us to understand how learning occurs, revealing that, in addition to health conditions, each human being has unique characteristics. There is therefore a need to adapt distance learning courses to ensure the production of knowledge and the development of skills among students, taking into account individual characteristics.

However, customizing the process for these courses is a significant challenge, as classes are composed of people from different cultures, regions, and other specificities, which does not allow for small groups to be considered, but only each individual.

And despite criticism, such as that of Neil Selwyn (2019), a large body of literature considers technological involvement to be essential. Therefore, we cannot fail to address the most widespread tools today, artificial intelligence (AI). They qualify as an excellent option for use in educational institutions because they serve the purpose of collaborating with the teaching and learning process that is aligned with the demands of society (Queiroz et al., 2024).

This study therefore aims to analyze Brazilian empirical studies in order to verify how AI impacts teaching and learning processes in distance learning courses, based on the fundamentals of neuroscience and personalized teaching.

1.1. Neurosciense in the teaching and learning processes

Personalized teaching is recommended to ensure efficiency in the teaching and learning process. To this end, it is essential to understand changes in ways of thinking. Digital information and communication technologies have been largely responsible for the conceptual shift in society and, as a result, it is necessary to understand the significant changes, including changes in ways of thinking and acting. Unlike traditional teaching, which considered collective needs to create educational processes, current literature points to personalized teaching (Pessoa; Botinha; Costa, 2018).

Advances in neuroscience should therefore be highlighted. After decades of study, it is known that the processes involved in human learning are products of brain activity (Portes, 2015). Neuroscience can be understood as a group of disciplines that study the brain and should be conceived as a set of sciences whose objective is to investigate the nervous system and its respective functioning, in addition to the relationships between brain activity, behavior, and learning (Portes, 2015).

Neuroscience—as the field of neuroscience will be called—is constantly advancing and is fundamental to a better understanding of how the brain works, in a broad sense. It seeks to understand issues relevant to treating diseases and improving learning methods.

With its broad scope, this science is interdisciplinary and encompasses various fields of study. Due to the complexity of brain function, it is divided into several units of study, each with its own level of analysis. The approach of this work focuses on Cognitive Neuroscience.

It is their principles that allow us to understand that learning is the constant process of the brain reacting to stimuli from the environment and activating synapses – connections between neurons through which stimuli pass (Rozal; Souza; Santos, 2017). According to the authors, it is in the synapse that learning

occurs, and if it is blocked, the student does not learn. The circuits are activated by stimuli or repetition, and the more one learns, the more the brain changes.

Stimuli must be varied, complex, harmonious, and challenging in order to meet these requirements (Pessoa; Botinha; Costa, 2018). Teaching must be appropriate, efficient, and preferably use technological resources that also facilitate monitoring.

That being the case, it is necessary to understand the difficulties faced by each student involved. Neuroscience contributes to this understanding. Portes (2015) cites dyslexia as an example. The estimated incidence is between 10 and 20% of children, and neuroscience shows that the difficulty is caused by flaws in phonological or visual processing. With knowledge of the cause, it is possible for the educational team to take more precise action.

Although neuroscience and education are interconnected, biological reductionism must be avoided, as social, emotional, cultural, and pedagogical factors also influence learning. Given so many factors, personalization is a promising path, as it takes into account the health and intrinsic conditions of each individual.

1.2. Teaching Personalization

Human beings' distinct needs overlap with one another, and a new need arises whenever an old one is met (Freire; Oliveira, 2021). Thus, students have different needs at different times, which highlights the importance of personalizing teaching.

Personalization immediately leads to active methodologies, in which knowledge construction is guided by the student's interests. Awakening this interest is directly related to the personalization of teaching. From this perspective, Freire and Oliveira (2021) argue that considering that students learn in different ways and at different paces incorporates personalization.

First, it is necessary to understand what personalization actually is. Lima Júnior and Silva (2021), in research aimed at clarifying concepts and avoiding ambiguities about personalization, point out that it involves initiatives aimed at promoting autonomy, self-management, and metacognition among students through actions organized by the school. They add that the concept integrates theoretical assumptions focused on integral development, with any methodology that respects the multiple human dimensions.

The authors define personalized education as an educational approach in which teachers dedicate themselves to training students, recognizing them as protagonists in the teaching and learning process, with development occurring throughout their entire lives.

Personalized learning has two perspectives, according to Moran's studies (2018): a) from the students' point of view and b) from the educator's and school's point of view. For learners, it is about creating learning paths that are meaningful to each individual, encouraging them to learn, expanding their horizons, and promoting their freedom and autonomy. For teachers and institutions, it is an effort to meet the needs and interests of students.

To address the second point, which is essential for the first to exist, teachers need to identify each student's motivations. This is one of the great challenges of the topic, as it requires prior study. Freire and Oliveira (2021) also highlight this challenge and point out that technologies can emerge as allies in this process, facilitating the collection and analysis of information and enabling large-scale adoption. The authors also emphasize that personalization is not immediate, but rather a broad, adaptive, and progressive proposal.

There are platforms and applications that offer increasing possibilities for personalization and monitoring, such as adaptive platforms that instantly monitor student progress, suggest alternatives, and allow each student to study without a teacher at their own pace, up to a certain point (Moran, 2018). And when it comes to technologies, we are now entering the realm of emerging and already established AIs.

1.3 AI in Education

Learning must be constructed while human beings must be the subjects of this process, something that Freire (1996) advocated. For protagonism, high interactivity between teachers and students is necessary in activities that articulate theoretical and practical content in the context of social life. This practice requires autonomy and flexibility for teachers to adapt content to the specificities of students (Fialho; Barros; Rangel, 2019). However, several challenges can be listed for such conditions to be achieved.

It is therefore essential that teachers and institutions have the support of technology. This is highly recommended because they are already recommended for use in the teaching and learning process. And considering that this process, as already seen, is linked to brain development and that each student has their own learning pace, Santos and Vilaronga (2022) explain that it is necessary for teachers to have diversified teaching and learning strategies that can address the needs of different groups of students. The use of technological devices associated with educational proposals can result in better learning opportunities (Pessoa; Botinha; Costa, 2018). On the other hand, no tool, technological or otherwise, solves everything: it requires teaching mastery and generates new demands. Hence, AIs are presented as an option for teaching support.

The term Artificial Intelligence originated in computer science and was coined in 1956 by J. McCarthy, one of the founders of the field. Despite its origins, it is a multidisciplinary field (Valdati, 2020). “It is the ability of electronic devices to function in a way that resembles human thinking. This involves perceiving variables, making decisions, and solving problems” (Barbosa; Portes, 2019, p.16). It is, therefore, the simulation of human reasoning by machines that interpret data, make decisions, and learn continuously.

However, this is just one of many definitions. The issue remains unresolved, and it is possible to find concepts of AI with some differences, as there are still profound discussions about the term, especially about what “intelligence” is.

AIs are classified into two categories: narrow and general. Narrow AIs are designed to perform specific, predefined tasks, such as Google Search. General AIs, on the other hand, have the ability to apply intelligence to a wide range of problems, such as Microsoft's 2015 Xiaoice robot, which was the first robot to act as a TV presenter (Parreira; Lehmann; Oliveira, 2021). They can also be classified as strong and weak, which is more commonly used in the literature. While the goal of strong AI is to build a machine that responds to general human intelligence, weak AI aims to replicate the performance of specific tasks (Rosa, 2019).

According to Gatti (2019), they can be used in formal or informal education and are emerging as allies. Parreira, Lehmann, and Oliveira (2021), in a study that divides innovations in education into three types, defend AIs as structural innovations. This is because their capabilities bring about profound changes. Gatti (2019) reinforces that AI allows for detailed monitoring of learning, identifying errors and doubts, which is essential for detecting inconsistencies in teaching and learning processes, enabling effective decisions.

In the context of Brazilian distance learning, which has seen an explosion in the creation of courses, such tools are essential for improving quality and achieving educational improvement goals. Arruda (2021) states that AI, with algorithms and through data analysis, can suggest resources, activities, and teaching methods that meet specific needs. This provides a more personalized and individual learning experience, allowing students to advance at their own pace and focus on the topics that interest them most. Therefore, AI is used to personalize the teaching process, which is considered essential for improving the quality of professional training in distance learning courses.

2. Methodology

This research took a bibliographic, qualitative, and exploratory approach to investigate the use of AI in personalizing teaching in distance learning courses. The Google Scholar database was used, including

indexed sources such as Scielo Brasil and university repositories, and descriptors such as “Artificial Intelligence in Distance Learning” and “Neuroscience and Personalization of Teaching” were employed.

To ensure relevance, priority was given to works in Portuguese published in the last five years with clear qualitative or quantitative methodology, from journals, scientific events, dissertations, and theses. Given the scarcity of empirical studies, news articles relevant to the topic were included.

For the theoretical basis, publications from 2000 onwards were considered, with an emphasis on the most recent ones. The Research Rabbit tool was used to expand references through seminal and reliable articles. Works lacking methodological rigor and with an indirect focus on the topic were excluded. As this research originated from a dissertation, another criterion was to disregard works from undergraduate and graduate courses. However, no empirical works were found at these two educational levels. Official data from the Higher Education Census (2020, 2022, and 2023) and ENADE (2022) were analyzed for contextualization, excluding documents prior to 2020.

3. Results and Discussion

3.1. Study with ChatGPT (Silva et al.,2023)

Next, we analyzed the work of Silva et al. (2023), presented at the Brazilian Congress of Informatics in Education (CBIE), which allowed for the discussion and application of AI as a tool to aid in the programming learning process, using a qualitative-quantitative approach. Sixty students from the 2nd and 3rd years of a high school course integrated with a technical course in computer science, offered by a Federal Educational Institution, participated. All participants were taking or had taken programming courses at the time.

In the first phase, through a preliminary test, called a “pre-test,” administered in person at the institution's computer lab, the authors sought to assess the participants' level of knowledge. Five basic-level questions (such as data input and output and arithmetic operations) and advanced-level questions (involving conditional branches and repetition structures) were administered.

After completing the pre-test, participants received guidance on how to use ChatGPT for assistance during the second test. The purpose was to use AI to seek immediate feedback and resolve doubts, such as errors and problems in the code created by the students themselves. They were also instructed to avoid ready-made answers created by the AI itself. Thus, the new test, defined as a “post-test,” was administered with five questions at the same level of knowledge and difficulty as the first test, now with the support of AI.

In comparing the tests with and without ChatGPT, the authors presented the percentages of students who answered completely, partially, or did not answer, “using descriptive statistical techniques.”

Tabela 1 – Results of questions asked in the pre- and post-tests.

Questions	Pre-test (without AI)			Post-test (with AI)		
	Done	Done partially	Didn’t do it	Done	Done partially	Didn’t do it
1	78,33%	6,67%	15%	86,67%	6,67%	6,66%
2	83,33%	5%	11,67%	86,67%	5%	8,33%
3	60%	15%	25%	76,67%	13,33%	10%
4	33,33%	28,33%	38,34%	55%	20%	25%
5	16,67%	11,67%	71,67%	46,67%	33,33%	20%

Source: Adapted from Silva *et al.*,2023[1].

[1] The exact rounding method and the number of decimal places used in the study were not specified.

It should be noted that the presentation of data in the original study does not detail the statistical criteria adopted for the number of decimal places, which may partially compromise reproducibility. Nevertheless, the results generally show the evolution in student performance with the use of AI.

In the pre-test, it was observed that as the difficulty level of the questions increased, so did the number of students who were unable to solve them. However, with the help of ChatGPT, the number of students unable to solve the questions decreased considerably at all stages. In addition, there was a significant increase in the number of students who were able to solve the questions completely or partially.

The authors also investigated, using the same strategy, students' perceptions of the use of technology and used the Likert scale to measure the results. They found that 95% of participants agreed with the use of tools such as ChatGPT to assist in teaching programming. In contrast, 10% of students believe that technologies interfere with relationships between teachers and classmates. Regarding the advantages of using technology in the discipline, 91.7% of participants stated that programming had become easier and more accessible; 86.7% of participants considered the tool effective in assisting learning; 90% of students agreed that it could complement traditional teaching; and 96.8% of them confirmed its usefulness in problem solving, with no disagreement on this last question. On the other questions, only 1.7% of students expressed disagreement.

3.1.1 Analysis of results

The results indicate substantial AI involvement. It is important to note that the students already had prior experience, as they were taking or had already taken related courses. Even so, in the two most complex questions (levels 4 and 5), the rate of non-response was considerably high in the initial test.

By focusing on specific issues and providing the necessary support, AI helped them find solutions to the questions posed. It facilitated both understanding and problem solving, reducing the number of cases in which students were unable to complete the tasks, as well as increasing the number of correct answers, either total or partial.

AI has shown great potential for enabling personalized teaching and enhancing the learning process, even in an isolated application. With continued use and careful planning, its positive effects can be even greater. Further practical studies are needed to fully validate these results. Data on the perception of AI use is relevant because, in addition to the tool's efficiency, it is crucial that it be widely accepted by the student community. Low attractiveness leads to disuse.

3.2 Study with non-guided AI (Arruda, 2024)

Another study analyzed was that of Arruda (2024), who also analyzed the perception of higher education students in distance learning, in the Pedagogy and Administration courses at the on-site support center of a private institution located in the city of Recife, in Pernambuco - PE. As a technique, she used semi-structured interviews and investigated the free use of AI among students, not guided by teachers. Twenty-three students participated, excluding those who do not use AI.

The students stated that they use AI to organize study schedules, scientific research, transcribe class notes, create PDF summaries, translate texts, among other things. The author asked participants about the advantages, difficulties, and/or challenges, as well as its influence on learning. Regarding the latter, it was pointed out that AI can explore new concepts and approaches more quickly, unlike a printed book.

When investigating the specific improvements that AI would have provided to students, a significant improvement in learning ability was noted, with the use of mind maps, better analysis of statistical data, and an increase in the quality of research conducted. Regarding the perception of changes in academic performance, participants noted a significant improvement in grades, and the main benefit/advantage was the personalization of learning and access to relevant information. Difficulties included obtaining reliable information and the limitation of free resources.

The author concluded that the results confirm the perception that AI contributes significantly to both learning and academic performance among distance learning students. “AI not only facilitates access to information and educational resources, but also improves students' learning ability, making the process more efficient and tailored to their individual needs” (Arruda, 2024, p.67).

3.2.1 Discussion of findings

This study also revealed that the AIs used by students made learning more efficient and adaptive, as well as motivating and engaging them, enabling more dynamic and interesting learning, which benefits both academics and the educational institution. In addition to direct use with students, AI can also indirectly support the personalization of teaching.

The studies discussed address specific applications for data collection, more precisely regarding student use. They demonstrate important positive results, but these require further investigation and, above all, analysis in the school routine. Based on this need, the large-scale application was analyzed over a considerable period of time.

3.3 Institutional application of AI – Redação Paulista (SEDUC-SP)

At the end of December 2023, the São Paulo State Department of Education (SEDUC-SP) announced that students in the final years of elementary and high school and their teachers would receive AI support in the teaching and learning process in 2024. The Redação Paulista platform gained a virtual correction assistant, whose goal was to streamline and facilitate revisions, with a view to increasing the number of productions in 2024.

According to the ministry, the state seeks to ensure better writing so that the best scores are achieved in assessments such as SARESP (São Paulo State School Performance Assessment System) and IDEB (Basic Education Development Index). SEDUC reported that, when entering the text, students have access to a spell checker. After corrections, the platform enables the text to be sent to the teacher, who, upon receiving it, automatically receives indications as to whether the mandatory evaluation criteria have been followed. The teacher reviews and gives the final word, being able to change the grade, add to, and modify the evaluation made by the AI.

Also at the end of December, Laura Mattos, from Folha de São Paulo, reported on the case and provided important figures. “Since the launch of Redação SP, 3.5 million texts have been produced by students from the 6th grade of elementary school to the 3rd grade of high school” (Mattos, 2023, n.p.). After the launch of the Platform, the average was 1.5 essays per student per semester, considering 2.4 million students in these grades. According to the ministry, the ideal is for each student to write at least one essay per month with the implementation of AI, which began testing in August 2023 and was implemented on November 30, 2023.

In June 2024, SEDUC announced that by the last week of May, 4.6 million texts had already been produced and corrected by teachers. This number is 41.7% higher than the entire second half of 2023. In July 2024, the ministry published that the number had jumped to almost 7.7 million essays completed and corrected by students from the 6th grade of elementary school to the 3rd grade of high school and that, in 2024, there were 2.5 million students in these grades.

3.3.1 Reflections on the observed impacts

Queiroz et al. (2024) highlight that the strategy implemented, in addition to optimizing administrative management and accelerating the correction process, contributes directly to the personalization of teaching. This is because faster feedback helps to fill gaps in the process, being more efficient and effective, as it reaches the student while they are still engaged with the topic. A delayed assessment would reach them at a time of lesser interest.

AI has optimized teachers' time, enabling more effective feedback to students. Instead of conducting broad, generic reviews, the technology acts directly on identified inconsistencies. Thus, AI applied on a

large scale in the country's largest basic education network, even if in isolation in a specific area, has had a highly positive impact on the personalization of teaching.

On the other hand, Queiroz et al. (2024) also shed light on the impact on teachers' professional lives, as technology alleviates the burden of grading, allowing for higher quality performance. Such implications have an important effect on the personal lives of these professionals, as they reduce problems and absences due to health issues.

These impacts and implications are being observed in face-to-face teaching, but are equally applicable to distance learning, since the school infrastructure was developed with the same standards. As Mattos (2023) explains, writing classes take place in rooms equipped with one computer per student, and text production is done directly on the Redação SP platform, even within the school environment. The same applies to the first paper discussed, on ChatGPT in programming classes, mediated by the internet and computers.

In addition to practical studies, the literature presents other applications of AI in education. Costa, Feitosa Filho, and Bottentuit Júnior (2019) affirm that AI has the potential to create more flexible teaching environments and summarize in their study the contributions to the pedagogical architecture of hybrid and distance learning courses. For Modesto (2023), examples include learning systems based on collaboration and dialogue that organize tasks and mediate group discussions; augmented virtual reality, which creates immersive environments, among others.

From the perspective of planning educational activities outside the classroom, there are also various ways in which AI can be used. In November 2023, the Federal University of Lavras, in Minas Gerais, announced that it had developed an AI solution to predict student dropout and retention rates, with an accuracy rate of 87% for retention and 93% for dropouts.

With adaptations, this resource can be used in any modality, especially in distance learning, where interaction with systems allows for more accurate data. This occurs in Virtual Learning Environments (VLE) and the data informs the institution's decision-making.

Thus, it is clear that the impacts that AI can have on education in general are beneficial. Like all innovations in teaching, the adoption of AI requires attention to the most current evidence. And when it comes to technology, ethical and privacy issues are key points.

4. Conclusion

Through the analysis of practical cases in classroom and distance learning courses at the final levels of elementary, secondary, and higher education, both in public and private initiatives, it was found that AI is a highly versatile tool with the capacity to positively impact various strategic aspects directly and indirectly related to the teaching and learning process. These technologies apply to all modalities, but they especially benefit distance learning due to its specific characteristics.

Face-to-face courses need to create environments that integrate virtual learning platforms, bringing students closer to these technologies. In contrast, distance learning courses already make intensive use of technology as an essential prerequisite for their functioning. While face-to-face teaching creates specific virtual environments, distance learning allows AI to be used throughout the institutional structure. The impact of AI on these courses, in terms of personalizing teaching, can be considerably greater compared to the current classroom-based model of Brazilian education.

Then, based on the discussions, the proposed research problem was revisited: “How does Artificial Intelligence impact the personalization of teaching in distance learning courses, considering both its potential and the ethical and privacy challenges involved in its implementation?” This was discussed below based on the works analyzed.

The research highlighted the various possible ways of using AI, both for individualized tutoring and for personal organization support. Although the results of AI are positive, success also depends on students' skills, such as critical analysis of feedback.

AI goes beyond simply filling gaps in learning related to course syllabi; it also promotes the development of skills that are rarely explored in the traditional model and difficult to measure quantitatively.

It was also found that AI contributes to increasing teachers' efficiency and effectiveness in dealing with students' individual difficulties, identified through their written work. Teachers were able to focus more directly on the specific needs of each student, providing more personalized and assertive monitoring.

The AI used had an impact on improving the logistical and administrative management of the proposed process, directly optimizing teaching time, allowing for higher quality feedback, acting individually, which was not possible before due to high demand.

However, it is also necessary to consider the side effects of the intensive adoption of these technologies, especially with regard to the possible reduction in teaching positions due to the automation of pedagogical tasks. In addition, the stylistic standardization promoted by AI systems can lead to the discarding of textual productions that, although relevant, do not conform to predefined standards, restricting diversity of perspectives and academic creativity.

On the other hand, the use of AI requires strict security and privacy measures to protect students and professionals. Although the results observed with the use of AI are largely positive, it must be recognized that its adoption also raises legitimate concerns. Among them is the possible limitation of teacher autonomy. Although promising, the application of neuroscience still needs further study due to the cognitive complexity involved.

The ethical and pedagogical challenges of AI in distance learning require further attention, especially with regard to data privacy, teacher autonomy, and impacts on pedagogical practices. AI-based systems can monitor, store, and process large volumes of sensitive data, which requires algorithmic transparency and informed consent. In addition, the automation of pedagogical processes can lead to the standardization of teaching and reduce teachers' autonomy in choosing strategies and methods.

Furthermore, it is essential that the implementation of these technologies be supported by a properly trained teaching and administrative staff in order to efficiently exploit the full potential of AI. This implies that the continuing education of teachers, as well as other school staff members, should include specific training in the use of these tools.

The results presented, therefore, confirm the theoretical suggestions in the literature, which already strongly indicate the integration of teaching and technologies, with a current focus on multiple AIs. In this way, AI has the full potential to deliver the desired quality to distance learning courses.

This work, therefore, contributes to distance learning by deepening the understanding of how AI can be used to personalize teaching. By highlighting the connections between neuroscience, personalized teaching, and the use of AI, we offer an integrated and up-to-date view of the challenges and potential of this technology, with a view to contributing to a possible improvement in quality.

A key limitation is the absence of a methodological plan for collecting and analyzing primary data. Although the analysis of experiences and documents has provided consistent insights, it limits the conclusive scope of the research. It is therefore recommended that future studies adopt more robust empirical approaches in order to validate and deepen the findings, taking into account Brazilian specificities, such as regional and cultural ones.

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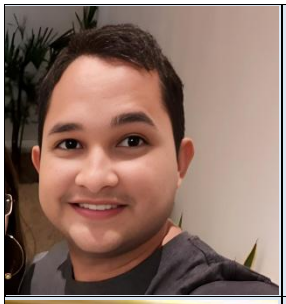

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