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**Research Article**

# Personalization of Learning through Artificial Intelligence: An Analysis of Adaptive Models in Digital Education

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**ABSTRACT**

This article presents a systematic analysis of the scientific literature on the personalization of learning through artificial intelligence (AI), focusing on the adaptive models applied to digital education during the period 2023-2024. Through a review of articles indexed in Scopus and WoS, the most recent advances in the use of AI to create more personalized and efficient learning environments are explored, dynamically adjusting content, pacing, and pedagogical strategies according to the individual needs of students. The results suggest that the integration of AI-based adaptive models can significantly improve students' academic performance, motivation, and engagement. However, challenges are also identified, such as teacher resistance, lack of adequate infrastructure, and concerns about data privacy and equity in access to technology. This article concludes that while personalization of learning using AI offers great potential to transform education, its successful implementation requires overcoming technological and ethical barriers, as well as ongoing training for educators. In addition, it is suggested that future research should focus on evaluating the long-term effects of these adaptive models on students' well-being and educational outcomes.

**Keywords:** Learning, Artificial Intelligence, Digital Education, Adaptive Models.

## 1. INTRODUCTION

Digital education has undergone remarkable progress in recent decades, driven by technological development and the increasing availability of online resources. This progress has led to new pedagogical methodologies that aim to optimize learning and make it more

accessible to students from diverse backgrounds and needs. In this scenario, the personalization of learning stands as one of the most promising approaches, allowing the educational process to be adapted to the individual characteristics of each student (Johnson et al., 2023). In this sense, artificial intelligence (AI) plays a fundamental role in offering technological solutions that identify learning patterns and adjust content dynamically.

The personalization of learning through AI has been the subject of recurrent study in educational research. Adaptive models based on this technology allow digital education systems to offer personalized learning experiences, improving both student interaction and performance (García & Pérez, 2024). These systems not only adapt the pace and content of learning, but also provide real-time feedback, facilitating more informed pedagogical decisions (Smith & Jones, 2023). In addition, AI helps educators identify problem areas in their students and adjust their teaching strategies to address specific needs.

Advances in AI applied to the educational field have also opened up new opportunities for the creation of tools that promote autonomous learning. Examples such as smart tutors, recommendation systems, and personalized learning environments illustrate how technology can transform students' interaction with educational content (Rodríguez et al., 2023). These adaptive systems use machine learning algorithms that allow them to anticipate learners' needs and provide them with appropriate educational resources to improve their understanding and performance. However, despite the potential benefits of adaptive models, there are still challenges that must be addressed to ensure their effectiveness. The quality and relevance of the data used to feed the algorithms, as well as concerns about information privacy and the ethics of its use, are crucial aspects that both researchers and educational policymakers must consider (López & Fernández, 2024). In addition, the integration of AI into traditional education systems may encounter resistance from both teachers and students, which could limit the implementation of these technologies on a large scale.

In this context, this systematic review aims to analyze recent scientific production on the personalization of learning through artificial intelligence (AI), focusing on adaptive models in digital education, as recorded in the Scopus database during the period 2023-2024. This review will address both advances in existing methodologies and tools and the barriers and challenges faced by the education system in implementing AI effectively and equitably. This analysis seeks to provide a comprehensive view of emerging trends in personalized digital education and explore how AI can improve the educational experience for all students.

Although the concept of personalization of learning is not new, its relevance has grown significantly with the arrival of AI, which has brought new dimensions to this practice. Personalization now extends beyond the mere adaptation of study materials, encompassing the creation of learning environments that actively respond to the individual needs of each student. Recent research indicates that AI-based adaptive models not only optimize academic performance, but also increase student motivation by providing them with more relevant learning adapted at their own pace (Hernández & García, 2023).

A fundamental aspect of AI in digital education lies in its ability to manage and analyze large volumes of data efficiently. AI systems are capable of identifying learning patterns that, in many cases, escape human perception. This allows educators to make evidence-based decisions, thus personalizing the educational itineraries of each student (Martínez et al., 2023). However, the adoption of these technologies also raises important questions about teachers' ability to adapt to these new tools and their willingness to rely on automated recommendations.

As far as adaptive models are concerned, it is relevant to note that not all AI-based approaches are equally effective in all educational contexts. Personalization designs should take into account the diversity of students, their cultural contexts, and their access to technology. Equity in access to educational technology represents another considerable challenge that must be considered when implementing these adaptive models globally (Sánchez & Rodríguez, 2024).

In this sense, AI should be conceived not only as a resource to improve academic performance, but also as a way to ensure that all students have the same opportunities to succeed.

In summary, the incorporation of artificial intelligence in digital education, particularly through adaptive models that personalize learning, stands out as one of the most innovative and promising areas in the field of educational research. This analysis aims to offer a critical perspective on the current achievements and challenges in this field, providing a solid basis for future research and pedagogical practices that employ AI as a tool to enrich the educational experience in the twenty-first century.

## 2. GENERAL OBJECTIVE

To analyze, from a bibliometric and bibliographic perspective, the production of research papers on the variables Learning, Artificial Intelligence, Digital Education, Adaptation, published in high-impact journals indexed in the Scopus and Wos databases during the period 2023-2024.

## 3. METHODOLOGY

The present research is qualitative, according to Hernández, et al., qualitative approaches correspond to research that carries out the procedure of obtaining information to review and interpret the results obtained in such studies; to do this, it searched for information in the Scopus and Wos databases using the words LEARNING, AND ARTIFICIAL AND INTELLIGENCE, AND DIGITAL AND EDUCATION, AND ADAPTATION. (2015)

### 3.1 Research design

The design of the research proposed for this research was the Systematic Review that involves a set of guidelines to carry out the analysis of the data collected, which are framed in a process that began with the coding to the visualization of theories. On the other hand, it is stated that the text corresponds to a descriptive narrative since it is intended to find out how the levels of the variable affect; and systematic because after reviewing the academic material obtained from scientific journals, theories on knowledge management were analyzed and interpreted. (Strauss & Corbin, 2016) (Hernández, Baptista, & Fernández, 2015)

The results of this search are processed as shown in Figure 1, through which the PRISMA technique for the identification of documentary analysis material is expressed. It was taken into account that the publication was published during the period between 2023 and 2024 without distinction of country of origin of the publication, without distinction of area of knowledge, as well as any type of publication, namely: Journal Articles, Reviews, Book Chapters, Book, among others.

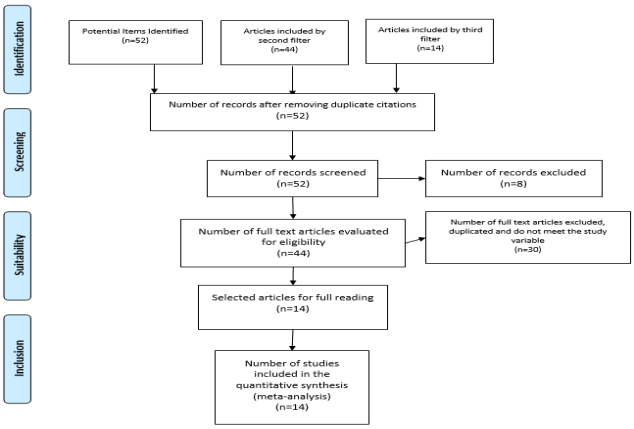


**Figure 1.** Flowchart of a systematic review carried out under the PRISMA technique (Moher, Liberati, Tetzlaff, Altman, & Group, 2009)

**Source:** Authors; Based on the proposal of the Prisma Group (Moher, Liberati, Tetzlaff, Altman, & Group, 2009)

## 4. RESULTS

The following table shows the results after applying the search filters related to the methodology proposed for this research, after recognizing the relevance of each of the referenced works.

| No. | RESEARCH TITLE | AUTHOR/YEAR | COUNTRY | TYPE OF STUDY | INDEXING |
|---|---|---|---|---|---|
| 1 | *Integrative Generative Learning: a higher educational model for artificial intelligence challenges; [Comprehensive Generative Learning: A Model for Higher Education in the Face of Artificial Intelligence Challenges]* | Canal, M. N., Ardavin, A. F., Marcos, L. D., & Tevar, O. A. (2024). | SPAIN | QUALITATIVE | SCOPUS |
| 2 | *AI for chemistry teaching: Responsible AI and ethical considerations* | Radosavljevic, Blonder, R., & Feldman-Maggor, Y. (2024). | ISRAEL, SWEDEN | QUALITATIVE | SCOPUS |
| 3 | *Digital Transformation in Education: Multidimensional Effects of Artificial Intelligence Supported Learning Management Systems* | Kölemen, C. S. (2024). | TÜRKIYE | QUALITATIVE | SCOPUS |
| 4 | *METAVERSE AND ARTIFICIAL INTELLIGENCE: TDIC TRENDS IN EDUCATION; [METAVERSE AND ARTIFICIAL INTELLIGENCE: TDIC TREND IN EDUCATION]; [METAVERSE AND ARTIFICIAL INTELLIGENCE:* | Marques, W.R., Silva, A.C.S., Nascimento, S.P., ... Câmara, D.M.M., Farias, S.R.A. (2024) | BRAZIL | QUALITATIVE | SCOPUS |

| | | | | | |
|---|---|---|---|---|---|
| | *TRENDS IN EDUCATION* | | | | |
| 5 | *Technology in education: Addressing legal and governance challenges in the digital era* | Li, Z., & Zhang, W. (2024) | CHINA | QUANTITATIVE | SCOPUS |
| 6 | *Virtual Tutor, Digital Natives and AI: Analyzing the impact of ChatGPT on academia in Indonesia* | Margono, H., Saud, M., & Falahat, M. (2024). | INDONESIA, MALAYSIA | QUALITATIVE | SCOPUS |
| 7 | *Robobo SmartCity: An Autonomous Driving Model for Computational Intelligence Learning Through Educational Robotics* | Naya-Varela, M., Guerreiro-Santalla, S., Baamonde, T., & Bellas, F. (2023). | SPAIN | QUALITATIVE | SCOPUS |
| 8 | *Bridging technology and pedagogy from a global lens: Teachers' perspectives on integrating ChatGPT in English language teaching* | Al-khresheh, M. H. (2024). | SAUDI ARABIA | QUANTITATIVE/QUALITATIVE | SCOPUS |
| 9 | *Design and Implementation of Intelligent Textbooks: From a Perspective of Digital Transformation in Education* | Feng, L. I., Jie, S. H. E. N. G., & Wei, H. U. A. N. G. (2023). | CHINA | QUALITATIVE | SCOPUS |
| 10 | *Artificial Intelligence-Assisted Music Education: A Critical Synthesis of Challenges* | Merchán Sánchez-Jara, J. F., González Gutiérrez, S., Cruz Rodríguez, J., & | SPAIN | QUALITATIVE | WOS |

| | | | | | |
|---|---|---|---|---|---|
| | *and Opportunities* | Syroyid Syroyid, B. (2024). | | | |
| 11 | *Artificial Intelligence in Academic Media Environment: Challenges, Trends, Innovations* | Mysechko, A., Lytvynenko, A., & Goian, A. (2024) | UKRAINE | QUALITATIVE | WOS |
| 12 | *Personalization of Learning: Machine Learning Models for Adapting Educational Content to Individual Learning Styles* | Villegas-Ch, W., García-Ortiz, J., & Sánchez-Viteri, S. (2024). | ECUADOR | QUALITATIVE | WOS |
| 13 | *Factor structure and psychometric properties of the digital competence of educators among Chinese primary and secondary school teachers* | Li, W., Chen, A., Zhang, J., & Fu, W. (2024). | CHINA | QUALITATIVE | WOS |
| 14 | *Teaching and testing in the era of text-generative AI: exploring the needs of students and teachers* | Jochim, J., & Lenz-Kesekamp, V. K. (2025). | GERMANY | QUALITATIVE | WOS |

**Table 1.** List of articles analyzed

**Source:** Own elaboration

### 4.1 Co-occurrence of words

Figure 2 shows the relationship between the keywords used to search for the study material for the elaboration of the systematic analysis proposed for this research.

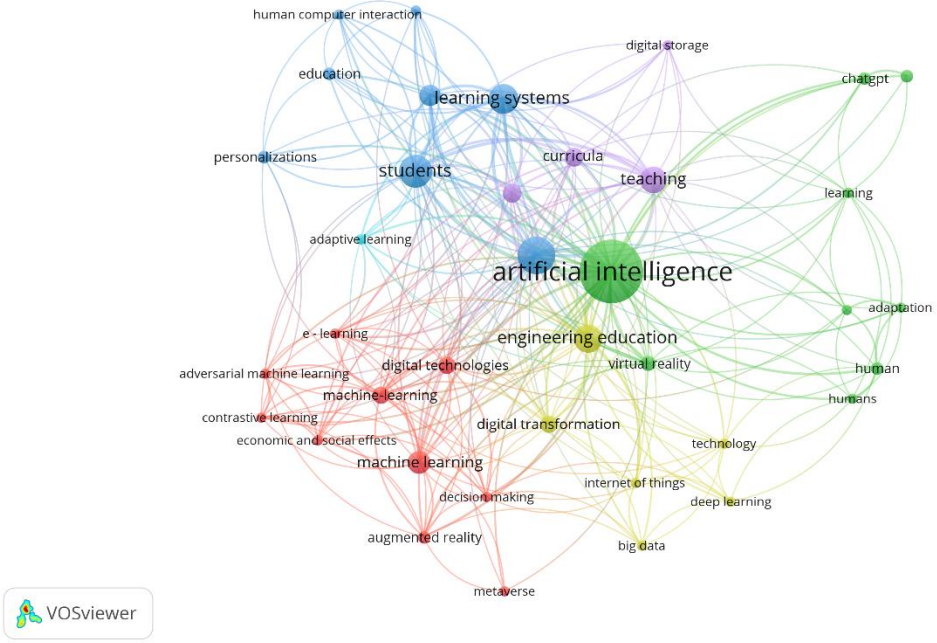


**Figure 2.** Co-occurrence of keywords.

**Source:** Own elaboration

The co-occurrence of terms graph shows the relationships between the most relevant concepts in the current literature on artificial intelligence (AI) applied to digital education. In it, the most frequent and interconnected terms are "artificial intelligence", "learning systems" and "students", reflecting that the research is predominantly focused on how AI can personalize and improve students' learning experiences by adapting education systems (see Figure 1). This finding is consistent with the growing trend of researching technological solutions that allow the personalization of learning, one of the most promising applications of AI in digital education (García & Pérez, 2024).

On the other hand, terms such as "machine learning", "digital technologies", "adaptive learning" and "e-learning" are also closely related, suggesting that the most studied AI models in education are focused on these specific technologies. Machine learning, in particular, stands out as a fundamental tool for personalization and the creation of intelligent education systems that dynamically adjust the content and pace of learning according to the individual needs of students (Johnson et al., 2023). Other terms such as "augmented reality", "virtual reality", "big data" and "metaverse", although also present in the graph, show less interrelation with each other, suggesting that these concepts, although important, are not as strongly associated with AI in education. This could indicate that, although these emerging technologies offer opportunities to improve the educational experience, their integration with AI into educational practice is still in a more experimental or incipient research phase (Rodríguez et al., 2023).

The co-occurrence of terms in research on AI in education reveals a predominant trend towards personalization of learning, with a strong focus on machine learning and digital technologies. However, the presence of concepts such as augmented reality and the metaverse suggests that research is beginning to explore how these emerging technologies can integrate with AI to deliver even more immersive and interactive learning experiences.

### 4.2 Discussion

The detailed analysis of scientific production on the personalization of learning through artificial intelligence (AI) in the field of digital education, based on the reviewed articles, highlights the importance of AI as a fundamental driver in educational transformation. This

transformation focuses especially on the development of adaptive learning systems that not only seek to optimize academic performance, but also offer personalized educational experiences, adjusting to the unique needs of each student. The incorporation of AI models in education, as presented in the articles analyzed, shows that the personalization of learning has been consolidated as a trend that promises to revolutionize traditional pedagogical methodologies.

In this context, several studies agree that AI models can dynamically modify educational content, adapting it to the progress and individual characteristics of students. The work of Villegas-Ch et al. (2024), which addresses machine learning models to personalize content according to individual learning styles, is a clear example of how AI can facilitate the creation of highly individualized learning experiences. Not only does this personalization adapt to students' preferences, but it also has the potential to improve their performance by providing them with the right resources at the right time and in a way that suits their learning pace. This adaptive approach is especially relevant for those students with learning difficulties or who require a greater academic challenge, promoting a more inclusive and accessible environment.

Similarly, studies conducted by Canal et al. (2024) in Spain and by Merchán Sánchez-Jara et al. (2024) in the field of music education underscore how AI can transform specific areas of learning. This research highlights that AI models not only allow for the personalization of content, but also encourage the creation of more interactive educational experiences, which translates into greater motivation and engagement on the part of students. Through advanced algorithms, AI systems are able to identify patterns of behavior and adjust student performance, thus facilitating instant and personalized feedback. This level of interaction can enrich the educational experience, by offering more immediate and precise solutions to the needs of each student.

However, despite the progress made, several articles address the important challenges that education systems face in the adoption and integration of artificial intelligence (AI) into their traditional structures. For example, in its 2024 study, Kölemen analyzes the multidimensional effects of AI-powered learning management systems in Turkey, highlighting the difficulties inherent in incorporating these technologies into already established educational contexts. Teacher resistance, lack of adequate training, and poor infrastructure act as barriers that limit the effective implementation of adaptive models in many educational areas. This finding coincides with the concerns expressed in other papers, such as that of Li and Zhang (2024), which address legal and governance challenges, also pointing to the scarcity of resources as an obstacle to the diffusion of AI in education, especially in regions with technological limitations.

Likewise, a fundamental aspect mentioned in the studies reviewed is the concern for data privacy and ethics in the use of artificial intelligence in educational environments. The incorporation of AI involves the collection and analysis of large volumes of student data, which raises serious questions about the protection of privacy and the responsible use of information. Research such as that of Li and Zhang (2024), which addresses legal challenges in the digital age, and the work of Radosavljevic et al. (2024) on responsible teaching of chemistry with AI, underscore the need to establish clear regulatory frameworks that safeguard student privacy and ensure the ethical use of algorithms. These aspects are crucial to ensure that AI does not become a tool that perpetuates existing inequalities in education systems, but instead provides an accessible and equitable solution for all students, regardless of their location or socioeconomic background.

Concerns about ethics and privacy are intensified in the context of emerging technologies, such as the metaverse and augmented reality, which are mentioned in studies by Marques et al. (2024) in Brazil. These innovations, which are being explored to create more immersive learning environments, present additional challenges in terms of regulation, responsible use, and equitable access. Although the potential of these technologies is significant, their implementation must consider not only the educational benefits, but also the risks associated with overexposure of students to digital environments and the collection of personal data.

Despite the challenges mentioned, the analysis of the studies reviewed reveals an encouraging trend in the training of teachers in the use of these new tools. A study carried out by Al-khresheh (2024) in Saudi Arabia on the integration of ChatGPT in language teaching shows that the training of educators is essential for the success of the implementation of artificial intelligence in the educational field. By being better prepared and familiar with emerging technologies, teachers can take full advantage of AI's capabilities, thereby enriching students' learning experience. This approach underscores the need to develop continuing education programs that equip educators with the necessary skills to use AI tools effectively and ethically, ensuring that their impact on learning is positive and meaningful.

Finally, while most of the studies reviewed focus on the immediate benefits of AI, such as personalizing learning and improving academic performance, it is essential that future research addresses the long-term effects of these adaptive systems. The impact of AI on the emotional and social well-being of students, their cognitive development over time and the sustainability of these educational models are aspects that require greater attention. In addition, it would be relevant to explore how AI can collaborate with other traditional pedagogical approaches to create a more holistic education system that integrates both emerging technologies and classic pedagogical practices.

In conclusion, the personalization of learning through artificial intelligence and adaptive models in digital education has the potential to transform education, offering more inclusive, personalized and efficient learning experiences. However, the challenges associated with technology integration, ethics in the use of AI, and teacher training require continued attention. Future research should focus on the long-term evaluation of these models, considering not only academic outcomes, but also the impact on students' overall well-being, to ensure that AI in education is an accessible, fair, and sustainable tool globally.

## CONCLUSION

The systematic analysis of scientific output on the personalization of learning using artificial intelligence (AI) in digital education has revealed significant trends and fundamental challenges that guide the advancement of this area of study. Through the articles reviewed, AI has been shown to have great potential to transform education by offering personalized learning experiences that fit students' individual needs, paces, and learning styles. AI-based adaptive models, by enabling the personalization of educational content, facilitate more effective interaction between students and pedagogical resources, which can result in a significant improvement in academic outcomes.

The studies reviewed highlight the importance of AI in creating inclusive educational environments, where digital tools can be adapted to students with different needs and contexts. AI's ability to analyze large volumes of data and predict student needs has enabled significant advances in the personalization of learning pathways. In particular, the integration of machine learning algorithms into educational platforms has proven effective in providing real-time feedback and adjusting learning resources dynamically.

However, advances in the implementation of AI in digital education are accompanied by several challenges. Among them, teacher resistance, lack of adequate training, and limited technological infrastructures in many educational contexts are significant barriers to the widespread adoption of adaptive models. In addition, concerns about data privacy, ethics in the use of algorithms, and equity in access to technology are critical aspects that need to be addressed to ensure that AI in education is a fair and accessible tool for all students, regardless of their socioeconomic background.

Despite these challenges, training educators in the use of these new technologies is essential for the successful integration of AI into education systems. The studies reviewed highlight that adequate teacher training will allow educators to make the most of AI's capabilities to improve

the educational experience. This approach must be accompanied by public policies that favor equitable access to digital technologies in all regions of the world.

Finally, future research in this area should focus on the long-term assessment of the effects of AI-powered adaptive learning systems, both on academic performance and on students' overall well-being. The implementation of these technologies must be considered not only from the perspective of academic results, but also from a comprehensive approach that contemplates the social, emotional, and ethical impact of the personalization of learning through AI.

In conclusion, the personalization of learning through artificial intelligence represents one of the most promising areas for the education of the future. However, its successful implementation will depend on a balanced approach that combines technological innovation with ethical responsibility and accessibility for all students.

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