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INTEGRATION OF ARTIFICIAL INTELLIGENCE IN TEACHER TRAINING: TRAINING TO INNOVATE IN THE DIGITAL AGE

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ABSTRACT

Artificial intelligence (AI) is already part of people's daily lives in Portugal, since it is present in practically every economic sector of society, making it difficult for citizens not to use this type of emerging technology in all kinds of contexts. The education sector is precisely one example of a context where AI is used and should be taught in a pedagogical way, helping to clarify its proper use for both students and teachers. In this sense, it is essential that AI is integrated into teacher training so that these professionals are prepared to use this type of technology, integrating it into the teaching-learning process. The research is carried out through a systematic literature review, carried out between 2020 and 2024, which seeks to identify the benefits of integrating AI in teacher training, thus contributing to the discussion and reflection on the subject. The results show that, although there is a need for more literature in the area, there is recognition of the importance of providing teachers with digital skills in the area of AI through continuous training so that they can be in line with the new educational reality.

KEYWORDS

Artificial Intelligence, Teachers, Digital Technologies, Teaching-Learning Process, Teacher Training

1. INTRODUCTION

Although society is beginning to come into contact with AI at different levels, whether in its daily personal and family life or at a professional and academic level, much is said about its challenges and the contributions it brings to organizations and to life. of citizens. It is such an emerging topic, so appropriate to reality and so interesting that it is currently being talked about everywhere. It is talked about in the media (television programs, news, newspapers, magazines and radio); It is also talked about in the educational, academic and scientific communities (in meetings between educational agents, conferences and congresses and other scientific events, but also in debates and in the literature found in scientific repositories and bibliometric databases); There is also talk of the national and international political spectrum (in public forums, in the regulations created, reports, recommendations and in the legislation that is being produced by the various European and Portuguese bodies).

But what is AI after all? A set of sciences, theories and techniques whose purpose is to reproduce by a machine the cognitive abilities of a human being. Current developments aim, for instance, to be able to entrust a machine with complex tasks previously delegated to a human (Europa, 2021). Also UNICEF, in the same year as the Council of Europe, presents a definition of AI that seems interesting to us: Machine-based systems that can, given a set of human-defined objectives, make predictions, recommendations or decisions that influence real or virtual environments. AI systems interact with us and act on our environment, either directly or indirectly. Often, they appear to operate autonomously, and can adapt their behaviour by learning about the context (UNICEF, 2021). When we talk about AI systems, we are referring to software on computers or machines programmed to perform tasks that normally require human intelligence, for example learning or reasoning. Through the use of data, certain AI systems can be "trained" to make predictions, formulate recommendations or make decisions, sometimes without any human involvement (Comissão Europeia, 2022).

Considering these definitions of AI presented by international reference organizations, the question immediately arises: If AI can do all this, simplify life for citizens, contribute to the speed of processes in organizations and faster production, then no should the education sector look at AI as an opportunity rather than a problem? Our answer is very clear, Yes! Yes, because the use of AI systems can potentially improve teaching, learning and assessment, provide better learning outcomes and help schools run more efficiently (Comissão Europeia, 2022). The cited document (Comissão Europeia, 2022) also states that AI systems can be used in different ways to support teaching or facilitate learning, namely: (i) Teaching students — using AI to teach students (student-oriented); (ii) Student support — using AI to support student learning (student-oriented); (iii) Supporting teachers — using AI to support the teacher (teacher-oriented); (iv) Systems support — use AI to support system-level (system-oriented) diagnosis or planning. This means that the contribution that AI can make to education (or rather, it already makes) is truly important, especially when we are increasingly immersed in online environments, where digital technologies play an absolutely vital role in achieving goals. teaching-learning processes.

Noting the importance of AI in education highlighted in the literature (Baltar & Baltar, 2023; Beijing, 2019; Cardoso et al., 2023; da Indústria, 2018; Hsu & Ching, 2023; Limo et al., 2023; Tavares et al., 2020), it becomes evident that all educational actors must be prepared for the new era of the digital society in which we find ourselves (Web 4.0).

This preparation seems to be able to take place in the context of teacher training, through training actions aimed at the integration, use and application of AI in the teaching-learning process. Teacher training in AI is vital since if students have contact with AI, parents have contact with AI and society has contact with AI, it seems logical and absolutely indispensable that those who teach must also have skills in this type of technologies. This will lead to the development of new digital skills to be considered in the context of the European Digital Competence Framework for Educators (C & Y, 2017; Redecker, 2017), which provides a general framework of reference to support the development of educator-specific digital skills in Europe (Comissão Europeia, 2022). Some of these AI skills are related to: (i) The use of digital technologies for communication, collaboration and professional development; (ii) Acquisition, creation and sharing of digital resources; (iii) Managing and orchestrating the use of digital technologies in teaching and learning; (iv) Use digital technologies and strategies to improve assessment; (v) Use digital technologies to improve inclusion, personalization and active participation of students; (vi) Empower students to creatively and responsibly use digital technologies for information, communication, content creation, well-being and problem solving (Comissão Europeia, 2022). Each of these skills is very important for teachers to be able to reach students through the integration of AI in their classes, which is why training aimed at understanding and using this type of technology is important.

With the development of this research, we intend, through a systematic review of the literature, to identify the benefits of integrating AI in teacher training, thus contributing to the discussion and reflection on the subject.

The article has four sections, the first being the introduction where we try to provide a brief contextualization. Subsequently, we present the main methodological options adopted for the development of this research. In the subsequent sections, we present and discuss the results obtained and present the main conclusions obtained with the development of this investigative work.

2. METHODOLOGY

The research is carried out through a systematic literature review which seeks to identify the benefits of integrating AI in teacher training, thus contributing to the discussion and reflection on the subject.

For this, the systematic literature review is adopted as the investigative methodology to support the study. The systematic review of the literature will be carried out with the support of a pre-defined set of criteria that will be essential for the serration of information on the theme addressed, namely: (i) Time interval: 2020-2024; (ii) Keywords (PT): A IA na formação de professores; contributos da IA para a formação de professores; benefits of AI in teacher training; Keywords (EN): AI in teacher training; contributions of AI to teacher training; (iii) Documents: reference articles and doctoral theses; (iv) Search language: English and Portuguese; (v) Bibliometric databases: B-On, Scopus and Web of Science.

Based on the criteria previously established, the general framework of the documents found is presented:

Table 1. Systematic literature review - Articles found

Id	Year	Title	Authors
1	2020	The role of artificial intelligence in teacher professional development.	Al-Zyoud, H. M. M. (Al-Zyoud, 2020)
2	2021	The responses to artificial intelligence in teacher integrated science learning training program	Gunawan, K. D. H., Kaniawati, I., & Setiawan, W. (Gunawan et al., 2021)
3	2022	Artificial intelligence and learning analytics in teacher education: A systematic review	Salas-Pilco, S. Z., Xiao, K., & Hu, X. (Salas-Pilco et al., 2022)
4	2023	Formação de professores para o uso de tecnologia: a inteligência artificial (IA) e os novos desafios da educação	Duque, R. de C. S., Monteiro, R. R., de Oliveira Filho, F. L. C., Loureiro, V. J. S., do Nascimento, I. J. B. M. F., Placido, R. L., da Silva , C. J., da Silva, J. M., Saraiva, M. do S. G., & Silva, A. M. de B. (Duque, Monteiro, et al., 2023)
5	2023	Formação de professores e a Inteligência Artificial: desafios e perspectivas	Duque, R. de C. S., Turra, M., dos Santos, A. A., Soares, L. G., Pascon, D. M., Bernardina, L. D., Peres, H. H. C., Barros, M. W. B., do Nascimento, I. J. B. M. F., Gomes, D. J. R. de A., Simões, G. S., & de Oliveira, E. A. R. (Duque, Turra, et al., 2023)
6	2023	Desafios e Oportunidades da Inteligência Artificial na Educação e na Formação	Santos, A. (Duque, Turra, et al., 2023)
7	2023	Redefining Teacher Training: The Promise of AI-Supported Teaching Practices	Kusmawan, U. (Kusmawan, 2023)
8	2023	Integrating AI tools in teacher professional learning: a conceptual model and illustrative case	Tammets, K., & Ley, T. (Tammets & Ley, 2023)
9	2023	Investigating Effective Ways to Use Artificial Intelligence in Teacher Education	Tunjera, N., & Chigona, A. (Tunjera & Chigona, 2023)
10	2023	A study on the need for AI integration in teacher education	Mahendran Maniam, D. K. (Mahendran Maniam, 2023)
11	2023	Introduction of Artificial Intelligence Literacy and Data Literacy in Computer Science Teacher Education	Olari, V., Zoppke, T., Reger, M., Samoilova, E., Kandlhofer, M., Dagiene, V., ... & Lucke, U. (Olari et al., 2023)
12	2023	The Role of Artificial Intelligence (AI) in Teacher Education: Opportunities & Challenges	Afiya Jamal (Jamal, 2023)
13	2023	Artificial Intelligence and the Future of Teaching and Learning	Miguel A. Cardona, Roberto J. Rodríguez, Kristina Ishmael (Cardona et al., 2023)
14	2023	The Opportunities and Challenges of Artificial Intelligence (AI) Application in Education: Literature Review	Wang Ruizhe, Jenny Chen Jie, Albattat Ahmad (Wang Ruizhe, Jenny Chen Jie, 2023)
15	2023	Conhecimento Poderoso e Inteligência Artificial (IA): Aliando Didaticamente Tecnologias para Educabilidades	Oliveira, E. A. D. S. (Oliveira, 2023)
16	2023	Formação docente e Inteligência Artificial	Aroma Bandeira, Jéfte Amorim, Pedro J. Florencio (Amorim et al., 2023)
17	2024	Use of Artificial Intelligence in Teacher Training	Wei Wu, Gulnara Burdina, Alena Gura (Wu et al., 2023)

Nine documents were excluded because they were outside the lines of the research and, in this sense, seventeen documents were considered for the purposes of this research.

A content analysis was carried out as part of the systematic literature review, involving the careful selection of a set of relevant articles through relevant databases and specific inclusion criteria. A data extraction process was carried out, identifying variables of interest and developing a protocol for the consistent extraction of information. The results were interpreted in light of the review objectives and discussed regarding implications for the study area.

3. DISCUSSION OF RESULTS

The research was carried out through a systematic literature review which sought to identify all the articles that discuss the benefits of integrating AI in teacher training, thus contributing to the discussion and reflection on the subject.

Amorim et al. (2023) identifies a set of benefits of integrating AI into teacher training, namely: Possibility of more effective planning, implementation and evaluation; Development of new critical, philosophical and ethical skills and competencies for teachers; Reformulation of degree curriculum and continuing teacher training; Definition of new ethical and organizational frameworks; Adoption of transversal, intersectoral and multisectoral practices for the planning and governance of AI in education; Reformulation of assessment models and development of teaching-learning systems; Inclusion of media education in teacher training and school curriculum; Automation of management and planning processes for teaching work (Amorim et al., 2023).This perspective brings us to the importance of looking at AI as a way of reformulating teacher training, looking to the future.

Personalization of Learning, expansion of capabilities and personalized dynamic experience are also other benefits of AI. Thus, in personalizing learning, AI can be directed by educators to personalize learning, offering an adaptive approach that meets the individual needs of students. In expanding capabilities it appears that collaboration between humans and AI does not replace the role of the educator, but expands their capabilities, allowing them to focus on more complex and meaningful aspects of education. A dynamic and personalized experience can be realized with an effective collaboration between educators and AI systems that enhances the educational process, transforming it into a dynamic and personalized experience (Duque, Monteiro, et al., 2023). This demonstrates that AI cannot operate alone in the educational process, but rather in conjunction with educational agents.

Other authors (Duque, Turra, et al., 2023) point out that AI allows skills development, particularly with regard to the ability to analyze educational data, mastery of technological tools and ability to effectively integrate AI into pedagogical practice. They also point to the personalization of teaching since AI can be used as a support tool to improve the quality of teaching and student learning. They also highlight opportunities for innovation, as AI offers perspectives and opportunities in teacher training, such as personalizing teaching, analyzing educational data and adopting innovative practices (Duque, Turra, et al., 2023). In this sequence, Oliveira (2023) also tells us that AI enables the personalization of learning, helping teachers to personalize teaching according to the individual needs of each student, offering adapted resources and activities. It also enables data analysis, as it can assist teachers in analyzing educational data, providing valuable insights into student performance and guiding pedagogical interventions. They also highlight task automation, as AI can automate administrative and repetitive tasks, allowing teachers to spend more time planning lessons and supporting individual students (Oliveira, 2023).

AI also allows pedagogical and technological support, facilitating the work of teachers and students with intelligent tutors, identifying trends and educational strategies. It also promotes innovative learning environments, such as gamification, video-assisted learning and immersive training environments, improving the educational experience for both teachers and students (Santos, 2023). In this sense, AI is expected to contribute to improving the educational experience of teachers and students, promoting more individualized and fluid learning.

AI can be used to integrate technology more systematically into teacher education programs. It can also help in the creation of personalized education systems, adapted to the individual needs of students. AI can be used to assist in assessing student performance and providing personalized feedback (Cardona et al., 2023). This is fundamental for increasingly inclusive and close teaching. AI can still be used to facilitate

collaboration between teachers, enabling the sharing of educational resources, effective practices and teaching experiences and to promote AI literacy among teachers, enabling them to understand and effectively utilize emerging technologies in their educational practices (Cardona et al., 2023).

AI can analyze large volumes of educational data to identify patterns, trends and areas for improvement in student performance, assisting teachers in making evidence-based decisions. Can provide more efficient and accurate assessment tools, allowing teachers to assess student progress more objectively and identify areas needing intervention. AI-based tutoring systems can offer additional support to students outside of class hours by providing personalized explanations, feedback and guidance. AI can help automate routine administrative tasks, freeing up time for teachers to focus on more meaningful activities such as lesson planning and developing innovative teaching strategies (Oliveira, 2023). The automation of these tasks is essential so that bureaucracy in teaching is reduced, processes are faster and employees can carry out other more complex tasks.

In addition to task automation, AI in teacher training helps identify the specific needs of each teacher, enabling personalized training programs; Enables the simulation of real-world teaching scenarios, assisting teachers in classroom management practices and effective instruction; Promotes teacher effectiveness and satisfaction, in addition to increasing the retention of these professionals; Facilitates data-driven decision-making, drives efficiency and fosters innovation in education; Prepares educators for an AI-driven world, empowering them to create engaging, personalized learning experiences for students (Mahendran Maniam, 2023). AI also allows you to visualize behaviors and interactions of pre-service teachers, predict dropouts and identify risk groups and support self-study of teachers in training. It also allows detecting discourse characteristics in textual data, evaluating the qualities of oral presentations through automatic scoring and assessing teaching competence through intelligent assessment systems (Salas-Pilco et al., 2022).

AI can help teachers perceive and understand what is happening in the classroom, assisting in decision-making and the development of professional competence (Tammets & Ley, 2023). AI can provide insights, integrate cues and knowledge-based reasoning into the official teacher qualification standard, promoting professional development. This type of technology can help teachers adapt teaching to student needs, allowing real-time adjustments according to student demands. AI can facilitate the integration of technological tools into teaching practice, promoting effective learning and aligning practices with competency frameworks (Tammets & Ley, 2023). In this regard, AI can also facilitate overcoming problems faced by teachers. Provides personalized pedagogical suggestions based on teachers' existing knowledge. Improves the effectiveness of lesson planning and the development of learning activities and provides real-time feedback to improve performance and teaching effectiveness; Enables the creation of more interactive and engaging learning environments and contributes to innovation and continuous improvement of teaching and learning methods (Gunawan et al., 2021). AI can play a crucial role in improving the quality of teacher education by providing access to high-quality educational resources and personalized learning materials. AI can provide feedback on areas in need of improvement, and provide opportunities for ongoing professional development (Jamal, 2023).

AI allows teachers to actively participate in a dynamic learning ecosystem, receiving feedback to constantly improve and democratizes access to teacher training, allowing even teachers in remote areas to access high-quality training modules; Granular and Real-Time. AI provides detailed information into aspects such as tone modulation, pace of content delivery, and student engagement levels, allowing teachers to improve their practices based on data-driven recommendations. Avatar technologies allow teachers to practice their teaching skills in simulated scenarios, receiving instant feedback and refining their practices based on AI-driven recommendations (Kusmawan, 2023). This is very interesting for teachers' commitment to their training and development as education professionals.

AI is also being used to improve teaching quality by helping teachers develop more effective and personalized teaching methods and enables the creation of individualized teaching plans for students, helping teachers meet the specific needs of each student. AI helps stay teachers up to date with changes in the school environment and perform their duties more effectively (Wang Ruizhe, Jenny Chen Jie, 2023).

In addition to these, Al-Zyoud (2020) highlight others such as: the development of AI-based educational software to raise teacher qualifications; the establishment of AI-based training trajectories for all education professionals; the provision of accurate databases in all areas of education, including human resources; Integration of databases into a global network to help advance teachers' careers (Al-Zyoud, 2020).

Integrating AI into teacher training can improve equal access to quality education in marginalized communities. Personalization of educational content through AI can make learning more relevant and

meaningful for students, meeting their specific learning needs. Investing in teacher training programs that develop technological and pedagogical skills is essential to address the skills gap and maximize the benefits of AI in education (Tunjera & Chigona, 2023). Also the collaboration between educators, educational technology experts, and other stakeholders is critical to ensuring the effective and equitable integration of AI into education, focusing on issues such as data privacy, equitable access, and fairness (Tunjera & Chigona, 2023).

Finally, Wu et al. (2023) highlight another set of AI benefits: Improving students' knowledge through training based on AI Effective combination of technology with traditional learning approaches; Potential to improve educational quality and improve teacher training; Opportunity to refine educational processes, reducing time and resource costs associated with the preparation of pedagogical personnel; Contribution to improving educational quality and developing highly qualified educators (Wu et al., 2023).

The integration of AI into teacher training represents a significant advance in contemporary education, providing a series of benefits that go beyond the simple modernization of teaching methods. These results highlight the importance of incorporating AI into the educational process to promote a more personalized and effective approach to learning, adapting to students' individual needs.

Another relevant aspect is the preparation of educators to face an increasingly technological educational scenario. AI in teacher education not only empowers teachers to use technological tools and resources effectively, but also develops their critical, philosophical and ethical skills necessary to deal with the ethical and social challenges associated with the use of technology in education.

The results seem to highlight the crucial importance of innovating in education, adopting advanced practices and technologies, such as AI, to continually improve the teaching-learning process, prepare teachers for the challenges of the future and promote quality and more accessible education for all.

4. CONCLUSIONS

The results show that, although there is a need for more literature in the area, there is recognition of the importance of providing teachers with digital skills in the area of AI through continuous training so that they can be in line with the new educational reality.

The systematic review of the literature on the integration of AI in teacher training highlights a series of significant benefits that this integration can provide. From personalizing learning to automating administrative tasks, to developing critical and ethical skills, AI offers a vast field of opportunities to improve educational practice and, consequently, improve the quality of education.

Integrating AI into teacher education not only enables the creation of more adaptive and personalized educational experiences for students, but also empowers educators to become more effective in their practice. Collaboration between humans and AI systems expands teachers' capabilities, allowing them to focus on more complex and meaningful aspects of education. Furthermore, AI analysis of educational data provides valuable insights that can inform evidence-based pedagogical decisions and continually improve the teaching and learning process.

By investing in integrating AI into teacher training, educational institutions can prepare educators for an AI-powered world, empowering them to create engaging, personalized learning experiences for students. Furthermore, by addressing issues such as equity in access and use of technology, collaboration between all stakeholders can ensure that the benefits of AI are maximized and distributed fairly across all educational contexts.

Therefore, it is essential to recognize the strategic importance of integrating AI into teacher training as an effective means of improving the quality of education, empowering educators and preparing students to face the challenges of an increasingly technological and interconnected world. This integration not only benefits individual teachers and students, but also contributes to the development of more robust and effective education systems on a global scale.

Finally, it should be noted that AI is an opportunity for teachers to modernize their educational practices, taking the opportunity to update and refresh their digital skills. If teachers seize the opportunity to understand the importance of AI in making education more inclusive, then they will certainly be at the helm of innovation and will make an indispensable contribution to achieving a teaching-learning process that is appropriate to reality.

Challenges are part of change and are fundamental to transforming education. We must take advantage of them to change the current teaching context!

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