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TRAINING OF COMPETENCIES IN ELECTRONIC ENGINEERING THROUGH ARTIFICIAL INTELLIGENCE: EVIDENCE, CHALLENGES AND CONTRIBUTIONS FROM EDUCATIONAL PSYCHOLOGY AND UNIVERSITY TEACHING AT THE POPULAR UNIVERSITY OF CESAR

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Summary
This article presents the integration of artificial intelligence in electronic engineering education, identifying emerging evidence, psychological challenges, and teaching considerations relevant to the Universidad Popular del Cesar. It shows a quantitative methodological design that combines surveys of teachers and surveys of electronic engineering students, analysis of ranges of uses of AI tools and a literature review on attitudes and psychological effects. The preliminary results highlight potential improvements in performance, self-efficacy and conceptual understanding, while identifying challenges such as biases, technological dependence and the need for teacher training for responsible and ethical implementation at the Universidad Popular del Cesar. It was achieved with the collection of empirical evidence and interpretation from approaches of educational psychology and teaching practices, to advance in a responsible and ethically grounded implementation at the Popular University of Cesar.

1. INTRODUCTION

The integration of Artificial Intelligence (AI) in university education is a booming phenomenon and is justified based on the available evidence. Institutions that train future professionals, particularly those who work in technological fields and advise the population, cannot be left out and must prepare for their implementation (Souzaa & Maierb). The electronic engineering training includes, among others, the areas of circuit theory, control systems and signal theory; concepts that demand a lot of study time. The use of AI tools in the teaching and learning of these concepts has begun to be studied, but not yet in depth. Specifically, the researcher asks the following question: What advantages and gaps have been evidenced in the use of AI tools in the knowledge and learning of fundamental concepts in the teaching of electronic engineering? The response will make it possible to formulate recommendations for its proper implementation at the Popular University of Cesar.

The technological and psychological challenges posed by AI, added to the complexity of engineering teaching, suggest the need for a deeper articulation between education, educational psychology and integration of AI, supported by evidence. These premises lead to a second objective: to identify evidence and challenges in the use of AI technologies in the field of university education, educational psychology and teaching in electronic engineering, which make their integration into the Popular University of Cesar viable. The search for information that allows this purpose to be fulfilled accounts for the three main areas involved: education and educational psychology, AI in education and electronic engineering, with their respective subcategories. (Esquivel and Hernández2024)

2. THEORETICAL FRAMEWORK

The most relevant conceptions of the educational process are deeply linked and connected to the theory of educational psychology; from there, various theories on learning and motivation are deduced, which are fundamental to understanding how students acquire and retain knowledge (Soriano et al., 2024). In addition, important phenomena such as metacognition, which involves the ability to reflect on one's own thinking and learning, are explained. These conceptions are also the essential foundation of the practice of assessment, where it seeks to measure and understand the student's progress. They also allow us to understand, from the perspective of Technology, the way in which human beings integrate, in their own personal and professional learning process, various technologies appropriate and relevant to their context. The implementation of artificial intelligence in the educational field, as well as the adaptation of various teaching-learning tools, stands as a fundamental pillar in the construction of learning environments that are not only effective, but also stimulating, particularly in the training of electronic engineers. This approach becomes crucial in the face of the incessant challenges posed by a world in perpetual evolution, where technological innovation and adaptability become essential competencies for the professional future of students. Emerging technologies not only facilitate the assimilation of knowledge, but also foster more interactive and personalized learning, allowing learners to develop skills that transcend the boundaries of conventional education. Consequently, a range of opportunities opens up that will undoubtedly have a positive impact on the academic and professional career of those who are preparing to venture into this dynamic field of electronic engineering. (López et al.2024).

Educational AI is the concept that covers the design and implementation of computer systems, based on AI paradigms, in which pedagogical behavior is carried out by means of machines, simulators or computer agents (Rivera). These systems allow a student of a course to learn in a different way, because they are oriented to the personalization of the teaching-learning process, depending on the needs and interests of the student. AI tools are available that can be used in the teaching-learning process, such as intelligent tutoring systems, networked tutor systems and recommendation systems. These tools analyze the student's information and propose the following actions based on their context and objectives; Some even incorporate the evaluation facet and propose which aspect of the topic should be strengthened. The incorporation of educational AI involves the transformation of the educational process into an open system, in which there are constant interactions between students and machines, and machines are able to adapt their behavior to students (Vera, 2023).

2.1. Education and educational psychology

Education is a complex and multifaceted process that involves a variety of actors, including students, teachers, educational institutions, and society at large. Despite the intricate nature of education, educational psychology has decided to concentrate its efforts on the exhaustive investigation and description of certain key areas and constructs in particular (Calderón, 2024). These areas include crucial aspects such as learning, motivation, metacognition, assessment, and more. The way in which these elements are perceived and understood by the different educational actors is fundamental, since these beliefs and conceptions influence how learning actually takes place and what are the factors that favor or hinder it. Consequently, the actions that are put into practice are determined by these understandings, which ensures that the deep knowledge and careful consideration of these constructs allow teachers to design and execute their decisions and actions in a way that produces more favorable and effective results in the teaching-learning process. The integration of technology in the classroom can facilitate and enrich this educational process, as long as both teachers and institutions adopt attitudes and beliefs that make the most of the possibilities that these technological tools have to offer in the contemporary educational context (Iturralde et al., 2024).

The conceptions of learning, as well as of the various processes that can facilitate or, on the contrary, hinder this important phenomenon, are of great importance in the field of education. These conceptions directly determine the actions that teachers carry out, as well as the way in which students face the challenge of learning effectively. In this context, motivation is presented as one of the most influential factors in learning, and it is in this sense that special attention should be paid to the decisions made by teachers in their daily practice. Such decisions may have the potential to encourage or, failing that, discourage it, and, therefore, significantly influence the quality of learning achieved by students (Velasco et al., 2024). Additionally, the evaluation process plays a crucial role, as it has a facilitating and enhancing character of the learning process, as long as it is understood as a permanent and continuous process that accompanies teaching from its inception (Vélez et al., 2024). This approach contributes significantly to more accurate and informed pedagogical decision-making. In this context, the artificial intelligence tools that are emerging today can provide valuable support to both teachers and students in the various

aspects involved in the learning process. Its appropriate and conscious use can cause profound changes in beliefs that determine which aspects of the learning process favor or hinder it, thus constituting an additional and promising path for the optimization of learning.

2.2. Artificial intelligence in education

Artificial intelligence in education encompasses those developments and content that use artificial intelligence techniques or tools for educational purposes. In this sense, an artificial intelligence education system is an application that integrates AI methods and techniques to create content, personalize teaching and learning, facilitate the educational process, or contribute to the development of knowledge and research in education (K-12) (Gallent-Torres et al., 2024). Tools that provide students with a direct aid in learning are classified as educational tools based on artificial intelligence. These tools are especially relevant because they are being used for learning and not under the supervision of a primary or secondary school teacher. The AI tools that help students in their learning process are ChatGPT, Copilot, Duolingo, Canva, among others, and these are just some of the tools that increase their use among students, although not always correctly (Di et al. 2024).

Artificial intelligence education systems are intelligent systems that help solve complex problems and become increasingly sophisticated, as they can play various roles in the educational process. However, integrating artificial intelligence into learning is not without risks, as its indiscriminate use can affect students' writing, creativity, reasoning, and learning. In this sense, it is argued that "ChatGPT is a technology with a great impact on education, although on their own they do not add or detract from training. Their potency or danger depends on how they are used." (Castillo et al.2024)

2.3. Electronic engineering and learning environments

Electronic Engineering programs must allow the development of competencies that not only add value to the training of their graduates, but also facilitate their adaptation to the constantly changing world of work (Moreno & de Cali). To this end, the use of teaching-learning methods that promote the development of critical, analytical and creative thinking skills is required, encompassing not only technical concepts, but also strategies that promote innovation. These skills are positively fueled by the use of emerging technologies applied to education, including artificial intelligence tools and online learning platforms that transform the educational process. However, their incorporation into the design of learning environments still faces technological, organizational, pedagogical, and cultural challenges that must be overcome to maximize their effectiveness and ensure that all students have access to a quality education that adequately prepares them for the challenges of the future (Muñoz et al., 2024).

The integration of emerging technologies, especially generative artificial intelligence tools, allows us to explore in great depth more adaptive teaching-learning processes, focused on the student and their various contexts, in addition to contributing significantly to the achievement of learning that is truly meaningful. Emerging technologies are those that develop new applications and innovations that impact education and other fields, and that, through feedback mechanisms, are the continuous object of research, creation and development. All this is done with the clear objective of delivering them to society through their production, marketing and use, generating a positive impact on learning and teaching. (Chávez-Boza and Erazo-Moreta2024)

3. RESEARCH METHODOLOGY

The research approach is mixed. The exploratory-descriptive design is combined, which allows characterizing the attitudes, comfort and reservations of the Electronic Engineering teachers of the Popular University of Cesar towards the incorporation of artificial intelligence in their classes, with the quasi-experimental design, which allows contrasting the effects on the learning of key concepts of an engineering with the use of ChatGPT and other generative AI tools. The research is part of the field of educational psychology, given the interest in the integration of AI tools in Electronic Engineering courses and the growing use of these resources in education, without any subject dedicated to their pedagogical application. (PIBAQUE QUIMIS, 2021)

The population is made up of teachers and students who study the Electronic Engineering programs of the Popular University of Cesar. A group of teachers is selected by means of non-probabilistic sampling by criteria and the students by means of an intentional non-probabilistic sampling. Questionnaires, an interview, specific rubrics, evaluation tests and knowledge control are used as data collection instruments. The information is obtained in the first two academic periods of 2024. The ethical criteria of tacit consent and confidential information are considered, and measures are applied to minimize bias in data collection and analysis. The consistency and validity of the instruments are determined from Cronbach's alpha coefficient and the expert judgment method, respectively.

3.1. Design and population

The study has a non-experimental design of a descriptive and cross-sectional type. Data collection was carried out from two samples: one of 22 professors who teach electronic engineering courses and another made up of 59 students of the Electronic Engineering programs of the Popular University of Cesar who were enrolled in at least one course where generative AI tools had been used.

The teachers were intentionally selected, considering that generative AI tools had been used in their classes and that they had, at least, a basic level of training in the use of AI. The selection of the group of students was carried out through a non-probabilistic convenience sampling. All subjects provided informed consent for participation in the research.

3.2. Instruments and procedures

A questionnaire on the use of AI tools in education, a semi-structured interview were used to investigate the teachers' perception of the integration of AI in their activity, a rubric to evaluate a set of Electronic Engineering activities and a test to assess the learning of basic concepts of Digital Electronics. The questionnaire, designed by the author and validated by expert judgment, consisted of 29 questions and was applied to 182 students from 5th to 9th semester of the Electronic Technology Design Engineering program. In the first three questions, those consulted reported their use of ChatGPT to search for information, study or solve doubts. In a second block, they answered 18 questions made with the five-point Likert scale, and in a third block, they reported the frequency of use of 11 AI tools in the three activities for which they were evaluated. The switching of the first three questions for a single multiple-choice question, combined with the Likert scale in the second block, allowed us to obtain an analysis of variance that determined statistically significant differences in the comparison variables.

The interview allowed us to explore the perception of 45 professors from the School of Engineering about the integration of AI in their activity. Ten of them were evaluators of the three activities, and the rest applied a minimum of two. They were consulted on four topics: fluency in the production of texts with AI tools; training, comfort and reservations to integrate AI into their activity; and the identification of topics where their use should be avoided. The perception of fluency was synthesized into three categories: very fluent or easy, somewhat fluid or easy, and not fluent or difficult. Data were presented in frequency form to show coincidences.

3.3. Ethical and validity criteria

The development of the research contemplated the informed consent of all participants, in which the anonymous and confidential nature of the data collection was guaranteed, as well as its exclusive use for academic purposes. Possible biases in data collection were also considered, especially in teachers' perceptions, which could be influenced by the methodology of the study: although it was an exploratory study developed through the analysis of the answers in a closed questionnaire, in which most of the questions were single-answer, The analysis stage included the programming of a script that interpreted the answers considering a series of public criteria for each question.

The validity and reliability of the instruments was determined based on the judgment of experts and the analysis that allows the Consensus Method of the validity estimates with the Proportionality of the Common Variance, which estimates the validity of an instrument based on the fact that 50% of the questions penetrate each factor or component of the general model of the study. The validity of these instruments can be considered adequate for the development of an exploratory analysis.

4. RESULTS

The presentation of the results is divided into three sections. The first addresses the perceptions of teachers regarding the inclusion of AI in teaching in electronic engineering. The second analyzes the evidence of the effects of AI tools on the learning of key concepts in this discipline. The third points out the challenges and gaps found in implementation.

Teachers' perceptions of the inclusion of AI tools in the teaching of electronic engineering reveal generally positive attitudes, with a high degree of comfort in their use, together with certain reservations about possible detriments to learning. Consensus has been found on the need for support and training to improve the integration of these technologies in their classrooms. (PAZ-MALDONADO and FLORES-GIRÓN2021)

With proper use, AI tools produce positive effects on understanding concepts, retaining learning, learning speed, and finding additional information. However, their intensive use generates less depth in learning. Teachers warn that lack of internet access, technical difficulties, time pressure, organizational situations, and cultural constraints are the main obstacles in implementation.

4.1. Teaching perceptions of AI in the teaching of electronic engineering

A key part of the process of integrating AI into education is the willingness of teachers to embrace its use. According to the literature, AI can offer several advantages for teaching and learning at different educational levels; however, its effects have been explored in an incipient way in higher education contexts and, in particular, in the training of engineers in general and in electronic engineering in particular. Despite these gaps, teachers in the latter area have shown positive attitudes towards their integration. On the contrary, their comfort and confidence in the use of AI have been limited, and they have described the need to improve their training. (Niebla et al.2025)

The first evidence presented here explores the perceptions of a group of twelve professors about the use of AI tools in the teaching of Electronic Engineering. Although the results are preliminary, they provide a glimpse of the general attitude, comfort, and confidence that educators experience when considering their integration, as well as the points at which they should be trained to effectively use these tools. The analysis was carried out using a questionnaire based on a Likert scale, whose answers were subjected to descriptive analysis.

4.2. Impact of AI tools on learning key concepts

The use of artificial intelligence tools positively impacts the learning of key concepts of the courses of the academic program of electronic engineering of the Popular University of Cesar. Compared to other teaching methods, its use is associated with a greater understanding of concepts, better retention of them, a faster learning process, and less time spent searching for information. These findings respond to the research question on the

effects of the integration of AI tools in teaching-learning practices and to one of the three lines of research that seek evidence and contribute to the design of a plan of strategies that facilitate such integration. (Ortega et al.2025)
The analysis of the data obtained in the second subquestionnaire, complemented with information from interviews and a third rubric, allows us to conclude that the use of artificial intelligence tools positively impacts the learning of key concepts. The results, presented through a series of upholstered questions, indicate that, compared to other teaching methods, their use is associated with a greater understanding of concepts, better retention of them, a faster learning process and less time spent searching for information.

4.3. Challenges and gaps in implementation

The research has shown that the use of AI tools in e-engineering education faces barriers that limit its integration and pedagogical effectiveness. First, the use of AI requires having devices with internet connectivity. Second, institutions must have policies aimed at the evolution of an organizational, pedagogical and cultural environment that contemplates a real and effective incorporation of these tools within the framework of the educational ecosystem. If technology is available but not policies that favour its use, the impact of the use of AI in education is small. Thirdly, continuous teacher training is considered necessary to be able to properly incorporate these tools and take advantage of their potential for the improvement of the teaching-learning process.
In summary, the results obtained show that although AI can be used for the learning of electronic engineering, until now it has not been used continuously and in a structured way in the institutions that teach these programs; All the associated problems that restrict their use must be considered and solved so that a greater integration of these technologies in the teaching-learning process is possible.

5. DISCUSSION

The results suggest that, if teachers propose changes in curriculum design and classroom practices that incorporate the tools that AI makes available to them – if they take care to evaluate how and to what extent these resources are being used in their courses – and if students use them to facilitate their learning and improve their well-being, so the impact of educational AI on the learning process of electronic engineering at the Popular University of Cesar could be positive. On the other hand, the integration of these tools in learning environments should also be considered from educational psychology, in order to ensure that their use does not negatively affect learning processes and the well-being of users.
Although research in this regard has been scarce so far, students do not seem to consider them harmful. The possibility that AI facilitates the understanding of difficult concepts, favors retention and learning speed, and even reduces the effort when performing exercises, seems to be driving the use of these technologies by students. However, access to the Internet, the time available, and the use of ChatGPT to solve exercises are factors that limit its use in formal education.

5.1. Pedagogical implications

The most relevant pedagogical implications derived from the results point to the need to reformulate the curricular design of electronic engineering training programs, to reconfigure teaching-learning practices within the courses and to review the learning evaluation processes. In this sense, the integration of new digital tools generated from AI applications in the electronic engineering training courses of the Popular University of Cesar could be supported by a gradual implementation plan that includes the selection of specific applications, the realization of pilot tests in some courses and their subsequent scaling to other learning environments.
The success of these actions at the pedagogical level would depend on the design of teaching strategies and learning assessment based on the available evidence on the impact of AI systems on the learning processes of key topics in the discipline. Among the recommendations emerging from the literature review, it is suggested to have classroom activity design guides that, considering the use of AI-generated tools, propose the implementation of teaching-learning and formative assessment tasks that offer timely feedback to students. Likewise, quality indicators are postulated that facilitate a systematic monitoring of the results obtained and allow, based on their review, to carry out the continuous improvement of these practices.

5.2. Implications for educational psychology

The evidence collected suggests that AI tools can support various psychological processes related to student learning, satisfaction, and well-being. By facilitating access to information, understanding complex concepts, and improving the quality of response to assessment activities, AI could contribute to the achievement of expected learning and enhance the way students feel during their learning process. However, even if the use of these tools has a positive effect on learning and retention of key concepts in a topic, excessive or automated use of AI resources, such as answering questions on these platforms without having effectively understood the topic, could have a negative effect on understanding concepts and undermine learning. Therefore, it is essential that the use of AI tools is properly guided and controlled by the teacher. In addition, it is important to reinforce ethical considerations in the use of AI and promote students' reflexivity in interacting with these systems.
The use of AI tools should go beyond simple instruction on their use and encourage dialogue with students so that they feel comfortable with their incorporation into the learning process and make a significant contribution to their emotional well-being during it. The evolution of human-machine interaction should be approached in an analogous way to the incorporation of any other technology in the classroom, through a gradual process that includes the motivation, design, selection and evaluation of strategies, activities or types of tasks that are supported

by AI tools. In order to more effectively address the integration of AI tools in the learning of Electronic Engineering, it would be desirable to have an institutional program that contemplates the creation of technological infrastructure, teacher training and the generation of an environment of trust and exploration that contemplates both the contributions and the risks of the use of AI in these processes.

5.3. Institutional considerations at the Popular University of Cesar

The integration of artificial intelligence in electronic engineering education poses challenges that transcend teaching and learning processes, and require the gaze of institutional governance. At the Popular University of Cesar, this suggests the need to review technological policy, to strengthen infrastructure, to pay attention to the training and well-being of teachers, and to promote student accompaniment. While current AI tools are far from perfect and can replace teachers, they constitute a powerful extension of the human brain that has the potential to transform not only the learning process, but the entire way students and teachers are.

The establishment of a governance model that contemplates the adoption, use and evolution of these tools must be an institutional priority. Technology policy should include the safe and responsible use of artificial intelligence, and infrastructure decisions should ensure access to the cloud and the necessary processing resources. Teacher training and support actions must address the changes that technology proposes to the design, teaching, evaluation and tutoring processes. The well-being of teachers, who are usually overburdened and with little time for their personal lives, must also be prioritized. Last but not least, the integration of artificial intelligence tools in the teaching-learning process requires a cultural change that places the student at the center of the learning process.

6. Recommendations

Practical actions are proposed for the professors of the electronic engineering career of the Popular University of Cesar to integrate artificial intelligence in the teaching-learning process. They establish a plan for piloting and scaling up the integration of AI tools in career teaching, a set of guidelines for the design of teaching-learning activities with AI technologies, and a series of indicators aimed at evaluating the quality of the integration of AI tools in the learning process and verifying their real impact on student learning.

A staggered integration plan and a set of guides are proposed that take up evidence on the use of AI tools in the acquisition of fundamental concepts in the area of electronic circuits and their relevance for the rest of the career. The integration includes everything from the selection and piloting of a specific tool to the integration of generative AI tools in the design of learning activities and in the evaluation of learning. The activities are categorized and structured according to three considerations: the type of tool used, whether the use of the tool is mandatory in the activity, and the type of interaction between the student and the tool.

6.1. Strategies for integrating AI into electronic engineering courses

To achieve sound pedagogical results, an implemental and evidence-based approach is suggested. In the first instance, it is advisable to develop an integration plan to specify its applicability, extension and scalability. This includes: (i) the selection of tools based on established thresholds and processes; (ii) an essay limited to a group of students, with careful observation of the effects generated; and (iii) the subsequent adoption and scaling in other courses, with emphasis on the evaluation of quality indicators, learner outcomes and added value. Subsequently, evidence-based classroom practices can be established, which include: teaching guides, activities designed with the support of AI tools, and formative assessments that include advance feedback.

To conclude, quality indicators are proposed for the integration of AI tools in Electronic Engineering courses. First, it is necessary to consider the type of tool and its actual or potential role in the students' learning process. Secondly, it is suggested that rubrics be drawn up to check the effective application of technologies. Third, the learning outcomes of students who perform activities supported by AI tools should be monitored. Finally, it is advisable to periodically review the implementation based on the results obtained.

6.2. Evidence-based teaching practices

To facilitate the integration of artificial intelligence tools in electronic engineering courses, evidence-based teaching practices are proposed. Guides should be developed to guide teachers in the teaching of key concepts, as well as a proposal for the design of activities that contemplate their integration into learning environments. It is also suggested to apply a formative assessment model that allows monitoring the progress of students and a feedback strategy that supports their learning.

Integrating AI tools into electronic engineering courses that use large language models provides students with significant advantages. However, in order for these tools to really contribute to their learning process, it is important that teaching and assessment activities are adjusted. Teachers tend to have reservations about the implementation of these tools, and training and infrastructure gaps are perceived in the institutions. Therefore, a set of evidence-based teaching practices is proposed to help teachers effectively integrate these tools into their courses.

6.3. Quality indicators and assessment of learning

The integration of Artificial Intelligence tools in electronics education must be accompanied by a set of indicators that allow their quality and impact to be evaluated. Such indicators should range from the selection of appropriate tools for the course to the assessment of learning. This assessment should include metrics and information associated with the tools, a rubric to determine how much it supports students in meeting course objectives, as well as a follow-up of student outcomes in relation to the use of AI tools and a formal review of implementation.

A rigorous selection of the tools to be used in the course may involve the analysis of the recommendations of the main technological and educational media. Additionally, and as is done with other technologies, it is possible to create a set of aspects that a tool must meet to be used in the classroom. At the same time, each course that adopts any of these tools must have a set of evidence that allows determining whether its use in the learning environment enhances, limits or does not have an effect on student learning, thus configuring an impact analysis process.

7. Limitations and future lines of research

The results presented have several limitations. First, the population that served as the basis for the main evidence is made up of a relatively small sample of students, so they may not be representative of the entire population of the Popular University of Cesar (UPC). However, the overexploitation that has been made of AI tools in education, the negative attitude that a group of engineering students have expressed towards their use, and the reality that the UPC faces when implementing changes in the use of technology, support the interest of the problem posed. Secondly, the fact that only a few professors of the Faculty of Electronic Engineering have been consulted implies that it is possible that the perceptions of most UPC professors about educational AI are different.

The research has addressed only a few lines of integration of AI in the learning of electronic engineering. Future research questions should therefore broaden the exploration. For the design of activities with AI, for example, one could investigate how to include the generation of images or their use as a search assistant (similar to Google), and analyze whether their incorporation into class activities improves students' performance and use of time, as has been found in other contexts. Another interesting line is the integration of AI in theoretical learning models and the use of AI in well-being processes and human-machine interaction.

8. CONCLUSIONS

The integration of artificial intelligence in e-engineering education requires a change of mentality in teaching and assessment, so that AI is seen as an ally and not as a threat. At the level of educational psychology, support is needed for the achievement of significant learning, as well as for the well-being of students and the responsible use of AI tools, in an environment that favors human interaction and not its isolation. From the university, policies must be established, resources must be allocated, corporations must be provided with effective governance and teachers must be adequately trained. A correct use of AI in the learning of electronic engineering affects not only the comprehension, retention, speed of appropriation of concepts and the consumption of resources, but also motivation and the development of autonomy.

Research has found that the use of artificial intelligence tools can influence the understanding and retention of concepts and help accelerate learning, that teachers' comfort and confidence increase with the frequency of using AI applications in their subjects and that, although in general their attitude is positive, There are reservations about human-machine interaction and ethics, and more training is required for proper use. However, gaps and challenges that limit its integration are also detected: in the institution's infrastructure that prevents its use due to technological failures and in the teaching organization that does not consider the use of artificial intelligence in its design or in institutional governance; in the teaching-learning approach that does not seek adaptation to the individual characteristics of each student or encourage interaction; and in the culture that sees AI more as a risk than an opportunity.

9. BIBLIOGRAPHIC REFERENCES

1. Souzaa, M. G. & Maierb, A. T. (). Education in the rise of AI: an approach to the challenges of academic learning. proyectoetica.org. proyectoetica.org
2. Esquivel, G. H., & Hernández, P. A. (2024). Engineer's Challenge to Become a Teacher of Engineering in Industry 5.0. Studies and Perspectives Scientific and Academic Journal, 4(2), 1830-1848. estudiosyperspectivas.org
3. Soriano, K. M. G., Rosero, P. E. L., Guzmán, J. A. C., & Nieves, Z. J. L. (2024). Implementation in Project-Based Learning (PBL) in University Education: Impact on Student Motivation and Achievement. Revista Social Fronteriza, 4(5), e45456-e45456. revistasocialfronteriza.com
4. López, A. F. J., López, F. J., Ruge, I. A. R., & Cely, Ó. F. V. (2024). Exploring the impact of Artificial Intelligence on electronic engineering training. International Meeting on Engineering Education. acofipapers.org
5. Rivera, B. J. R. (). The integration of artificial intelligence in the design of personalized education systems. publicaciones.unad.edu.co. unad.edu.co
6. Vera, F. (2023). Integration of Artificial Intelligence in Higher Education: Challenges and Opportunities. Transform. revistatransformar.cl
7. Calderón, D. N. D. E. (2024). Intertwining Complexity: An Educational Revolution Toward Complex Thinking. Vida Magazine. revistavidacunori.com
8. Iturralde, J. A. B., Cajas, J. A. R., Cajas, E. P. R., Cajas, M. E. R., & Llumiquinga, L. J. C. (2024). The need for teacher training for an effective implementation of educational technology in the classroom. Ciencia Latina: Revista Multidisciplinar, 8(2), 2347-2367. unirioja.es

9. Velasco, V. E. M., Proaño, N. A. L., López, E. N. L., Frías, H. L. P., Mejía, O. B. A., & Yucailla, R. D. C. (2024). Influence of intrinsic and extrinsic motivation on the teaching-learning process: A systematic review. Revista de las Ciencias: Revista de Investigación e Innovación, 9(2), 95-111. utb.edu.ec
10. Vélez, M. F. A., Macías, M. J. E., Villafuerte, N. M. L., & Parrales, L. K. H. (2024). Development of critical thinking through the use of ICT in the formation of language and communication in higher education. Global Knowledge, 9(3), 123-132. conocimientoglobal.org
11. Gallent-Torres, C., Romero, B. A., & Adillón..., M. V. (2024). Artificial Intelligence in education: between risks and potentialities. … Educational. fcc.org.br
12. Di Santo, S., Skotiniotis, M., Vidal, A. P. M., Pérez-Espigares, C., & Vega, J. J. B. (2024). The use of large language models in the learning of Computational Physics. AI Nuevas, 108. ua.es
13. Castillo, H. M. M., Gaibor, C. G. R., Buitrón, C. V. C., Vivanco, L. G. R., & Guerrero, M. P. O. (2024). Artificial intelligence applied to learning. Scientific Code Research Journal, 5(2), 1956-1973. itslosandes.net
14. Moreno, J. C. M. & de Cali, S. (). EDUCATIONAL PROJECT OF THE ELECTRONIC ENGINEERING AND TELECOMMUNICATIONS PROGRAM. uao.edu.co. uao.edu.co
15. Muñoz, G. F. R., Delgado, J. C. V., & Dávalos, J. M. A. (2024). Artificial intelligence and governance in the academic and administrative management of higher education. Revista Social Fronteriza, 4(6), e46508-e46508. revistasocialfronteriza.com
16. Chávez-Boza, B. M., & Erazo-Moreta, O. R. (2024). Integrating generative artificial intelligence for learning programming fundamentals: a systematic review of the literature. Mexican Journal of Educational Research and Intervention, 3(2), 5-17. pablolatapisarre.edu.mx
17. PIBAQUE QUIMIS, E. D. (2021). ... PROGRAMMABLE ELECTRONIC AS A DIDACTIC TOOL FOR THE TEACHING AND LEARNING OF THE SUBJECT ARTIFICIAL INTELLIGENCE OF .... unesum.edu.ec
18. PAZ-MALDONADO, E., & FLORES-GIRÓN, H. (2021). Attitude of university teachers towards educational inclusion: a systematic review. Revista Brasileira de Educação Especial, 27. fcc.org.br
19. Niebla Zataraín, V. B., Beltrán-Lizárraga, M. G., Niebla Zataraín, J. M., & Sandoval-Chávez, D. A. (2025). Perspectives on Artificial Intelligence Adoption in Management Engineering Students at ITES Los Cabos, Mexico. RIDE. Ibero-American Journal for Educational Research and Development, 15(30). scielo.org.mx
20. Ortega, L. M. G., Carmona, E. R., & Acosta, L. M. (2025). Learning in Engineering supported by Artificial Intelligence (AI) tools. Inter-American Journal of Education and Pedagogy Research RIIEP, 18(2), 61-85. unad.edu.co