ARTIFICIAL INTELLIGENCE AND UNIVERSITY TEACHING: PERSPECTIVES TOWARDS PEDAGOGICAL TRANSFORMATION IN THE TRAINING OF ELECTRONIC ENGINEERS AT THE POPULAR UNIVERSITY OF CESAR

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Summary

The article discusses how pedagogical transformation in electronics engineering education can leverage artificial intelligence (AI). A literature review of recent years reveals trends in how AI is transforming higher education, which in turn offers new opportunities for the training of electronic engineers at the Popular University of Cesar. The use of AI-powered learning environments, such as virtual labs, intelligent tutoring, and adaptive formative assessment, is discussed. Proposals are put forward for the training of electronic engineers, including decision-making guided by data analytics and the inclusion of ethical and governance principles in curriculum design. AI has become one of the most impactful technologies in education and its use in the training of electronic engineers is already beginning to explore new dimensions. When approached from an active learning perspective, it can become an engine that supports the transformation of teaching practice and promotes the acquisition of technical and non-technical skills. However, the application of these technologies is conditioned by restrictions of availability, equity, and ownership. The lack of alignment between the evolution of technology and the preparation of the new generations of engineers is currently a serious challenge. Decisive leadership, vision and action are required, ensuring that the impact of AI in the training field is in line with the principles of safety and ethics.

Keywords: Engineering training, artificial intelligence, university teaching, pedagogical transformation.

1. Introduction

Artificial intelligence (AI) has ceased to be a mere aspiration or science fiction idea to become a technology that generates profound changes in people's lives, the economy and institutions. This phenomenon has not gone unnoticed by those responsible for higher education. In the field of university education, there are more and more publications that analyze the impacts that AI can have on various aspects of educational processes. However, most of them do not address the relationship between AI and electronic engineering, an area that will be affected by the introduction of equipment and infrastructure that must be used during the training process and that have led to the creation of products in the fields of art, cybersecurity, teaching resources, pedagogy, health and many other areas that belong to or would benefit society.

The aim of this article is to answer two questions related to the training of electronic engineers. First, how does AI enhance higher education environments and pedagogical practices? Second, what are the implications of applying AI tools and products in the training of electronics engineers? To this end, the current trends and themes of the publications identified through a bibliographic review are analyzed.

1.1. Context and relevance of AI in higher education

Artificial Intelligence (AI) is currently impacting higher education. On the one hand, the automation of tasks and processes requires re-evaluating content and pedagogical strategies; on the other hand, its use increases student learning and achievement. Trends such as self-publishing content, adaptive course design, personalized tutorials, formative assessments, virtual labs, and integrated advanced simulations guide the transformation of the educational context. In the future, AI will facilitate decision-making in curriculum design and quality education for all. However, the digital divide is still present, the lack of alignment between the teacher and technology exposes students to biases that affect the quality of their learning and privacy and protection are unavoidable issues.

Despite the changes in education, engineers continue to have a deficit in soft skills and adaptation to day-to-day life. Universities come to life with the use of tools powered by artificial intelligences that increase achievement at different levels. Its application goes beyond cost reduction and decision-making assistance when closing courses; The analysis of the data generated by these systems contributes to the creation of training programs adapted to the context. There is still little use of these technologies in the training of future engineers, however, their application in ethics and security issues is fundamental in the era of algorithms.

1.2. Focus of the article and research questions

The transformation of pedagogy in the training of electronic engineers through an active learning approach enhanced by artificial intelligence. Three aspects are analyzed, focused on the incorporation of technologies that improve teaching activities in the process of training electronic engineers. The first, the design and implementation of AI-powered pedagogical environments and practices; the second, AI-guided curriculum design; the third, the development of ethical, safety and responsibility skills associated with the subject of AI. The joint figure of these aspects guides the pedagogical transformation in the training of electronic engineers. By focusing pedagogical transformation on active learning, AI-provided aids are incorporated. A responsible, equitable and ethical use of AI in electronic engineering is proposed in the development of engineers for their professional practice.

The pedagogical transformation in the training of electronic engineers is articulated through an active learning approach, in which the aids provided by artificial intelligence are incorporated. Three aspects are analyzed, focused on the incorporation of technologies that improve teaching activities in the process of training electronic engineers. The first, the design and implementation of AI-powered pedagogical environments and practices; the second, AI-guided curriculum design; the third, the development of ethical, safety and responsibility skills associated with the subject of AI. The joint figure of these aspects guides the pedagogical transformation in the training of electronic engineers.

2. Conceptual framework

Artificial Intelligence and Active Learning

The ability of artificial intelligence (AI) to facilitate active learning offers a powerful new approach that combines the advantages of active learning with the use of artificial intelligence tools such as chatbots and generative tools. This approach uses online assistants in the learning process, provides different types of assessments, and uses intelligent tutoring. The environments and pedagogical practice proposed by this approach can be applied to different disciplines, including systems engineering and related fields of study, where technical aspects are essential for training.

University pedagogy and curricular transformation

Today, emerging technologies have driven profound changes in curricula, as the backbone of the curriculum is transforming into a data-driven curriculum. Predictive analytics, leveraging the massive amount of data generated by online or hybrid learning, makes data-driven curriculum transformation possible. The training of electronic engineers in the digital age requires technical skills in AI, IoT, data science, cybersecurity, among others. It also incorporates soft skills in the emotional (emotional intelligence), ethical (AI governance and responsible development) and social (teamwork) areas.

2.1. Artificial intelligence and active learning

Active learning appears as a pedagogical approach in which students participate in activities that encourage reflection and analysis. With the integration of artificial intelligence into this type of learning, it is possible to develop new approaches that rely on technology to enhance their results. In this sense, it is considered that pedagogical environments and practices can be enhanced through artificial intelligence in accordance with its use in the curricula of electronic engineer training.

The concept of active learning can be defined as a learner-centred pedagogical approach, in which the learner participates directly in the learning process through activities that encourage reflection and analysis, rather than the learner's simple reception of information; It is also considered a constructivist approach in which students supervise, discuss and validate the results of their work, as well as the level of learning achieved. However, although in this type of learning teachers assume the role of facilitators, resources such as virtual reality and simulation laboratories, intelligent tutoring systems and formative assessment mechanisms supported by artificial intelligence allow the presence of architects of the learning experience, whose use in the process can also be considered active learning.

2.2. University pedagogy and curricular transformation

Artificial intelligence technologies are going to modify the university ecosystem, producing profound changes in pedagogy and curricula, without there being a general consensus on how to carry it out. However, although these changes are different in each discipline, accumulating a certain degree of maturity, it is important that the issue is addressed in a horizontal, transversal way, since not all teachers have the necessary skills in the treatment of these technologies, nor is all the correspondence and analysis of the effects that they should produce foreseen.

The development of artificial intelligence requires that students, in addition to mastering economic and technological skills, have a solid knowledge base that includes the how and why of the causal relationship between the engineering phase of the problem and each of its development phases. This includes not only the creation of the algorithms, but also the process of capturing, storing and pre-processing the data, the administration and development of the models that will be used, which are above all to support decision-making, and the design of the management initiatives that will be optimized by artificial intelligence.

2.3. Competencies of the electronic engineer in the digital age

The accelerated adoption of digital technologies has created new challenges for electronics engineers. As digital systems, both software and hardware, intelligent and autonomous, are integrated into everyday technologies, the need arises for a professional profile capable of designing and developing these technological solutions. An electronic engineer in the digital age must not only possess strong technical competencies, but also soft skills that allow them to understand and respond to the responsibility and effects of their actions on people and humanity. In particular, the following competencies are identified:

TECHNICAL SKILLS: the basic technical skills of the electronics engineer are still valid; however, it requires the parallel mastery of new disciplines, the five types of competence required for education 4.0, continuous learning and the ability to design digital applications and products, as well as to execute and prototype them through appropriate simulation environments. The following areas of knowledge are critically needed: Artificial Intelligence, which is a cross-cutting area for all of them and, especially, for electronic engineering, where it is possible to design AI systems in products and applications; Internet of Things (IoT), which is a system of systems; connectivity technologies; integration and storage infrastructure; cybersecurity and blockchain; Ability to formulate and solve problems by means of mathematical models; Ability to redesign algorithms and create AI models; Development of digital products in the context of the Integral Design program.

SOFT SKILLS: The soft skills of the electronic engineer include proper communication, teamwork, leadership, and project management. The social ability to work in high-performance multidisciplinary groups is critical to respond to complex problems; It requires cognitive and cultural flexibility that allows understanding possible biases in management, application of a solution and response to the different perspectives contributed by members with experience in other fields.

3. Methodology

The methodology consists of a review of the literature, as well as its selection principles. The review of works that, based on the advances of AI, propose modalities, environments or pedagogical practices guided by AI and that can obviously influence the training of electronic engineers is considered. This search in dimensions related to the training of electronic engineers has been necessary given the evolution and growing impact of AI in society and in all economic sectors. All in all, the improvement of the quality of training and the strengthening of the graduates' capacities to direct and lead innovation, technology transfer and research processes in strategic areas for the country. The foundation of this part of the analysis is Hall and Oppenheimer, who warn that the quality of teaching with AI will not depend only on its incorporation into pedagogical practices, but also on the design and implementation of a curriculum according to the opportunities and challenges offered by the mastery of AI.

The topics will be grouped according to the relationships they establish between them and, based on the evidence that points to advantages, benefits or new paths that AI can offer in the training of electronic engineers, a synthetic characterization will be built to support the recommendations to take advantage of these environments and practices enhanced by AI.

3.1. Literature review and selection criteria

An empirical review that discusses how the active learning approach and artificial intelligence can be used in electronic engineer training environments. The methodology is aimed at the recognition of empirical evidence that supports the dialogue and supports the disciplinary offer. The selection process is organized into inclusion, exclusion and search criteria, and the analysis is developed through a thematic grouping. The review allows the disciplinary curriculum to be interconnected with support experiences in the specific conditions of their teaching environment.

The expected results allow us to recognize different approaches in the use of AI with the purpose of improving quality and equity in university education, highlighting the opportunity of a data-driven curriculum design and the development of training lines aimed at education in ethics and responsibility on AI.

3.2. Thematic analysis and synthesis of evidence

The emerging themes will be grouped based on the coincidence in their focuses, evidence or perspectives of study, and the integration will allow common points, contradictions and contradictions to be established. At the end of the compilation, these topics will be linked to the recommendations, culminating in the answer to the objective and the first question on AI-powered pedagogical practices and environments. This will facilitate the discussion connection with the more specific aspects of curricular transformation and development of competencies, addressed in the following three sections.

The pedagogical sector dedicated to the training of electronic engineers was impacted by the covid-19 pandemic, forced into a tectonic movement towards the flipped classroom, active learning, the use of virtual and mixed environments, and formative assessment. Although it was a catastrophe on a global scale, there are favorable aspects, including the exploration of educational environments enhanced by new technologies. However, trends indicate that the teaching-learning process inside and outside the classroom will not only incorporate digital tools, such as video cameras, LMS platforms or videoconferencing systems, which facilitated the remote performance of activities; The use of artificial intelligence and machine learning is expected to generate an azimuth change, such as the abrupt displacement of the Earth's crust that causes a tsunami.

4. AI-powered pedagogical environments and practices

AI can complement the areas of learning, mentoring, and assessment. At the level of environments, it promotes the development of virtual laboratories and advanced simulation, capable of bringing students closer to the practical experience of learning in difficult situations. In tutoring, tools such as intelligent assistance agents (AI) or network portals for monitoring the learning process can improve attention to students through data analysis. Finally, in assessment, AI-based formative assessment methods allow student progress to be tracked through continuous assessment and automated feedback. The use of these environments and practices favors the development of engineers capable of building AI-based systems.

AI can contribute to curriculum design. In the short term, the integration of AI into knowledge graph systems may allow universities to structure the curricula of different subjects around the teaching and learning of fundamental digital concepts. In the medium and long term, specific disciplines on ethical, privacy and responsibility aspects in AI are sometimes framed in general thematic groups that bring together the competencies that engineers are expected to have in these areas at the end of their training.

4.1. Virtual labs and advanced simulation

Virtual simulations and laboratories are solid tools for the training of electronic engineers, even in the distance modality. From complex systems that simulate objects, phenomena, processes and systems, they open up multiple possibilities for interaction and collaboration, both among students and with the simulated objects. In this field, artificial intelligence allows the creation of increasingly plausible simulations in which uncontrollable variables can be introduced in a real situation. In science, technology, engineering and mathematics training, they have been used to offer interactive experiences in branches such as biology, physics and chemistry, and are being explored for the teaching of electronic engineering.

Providing these virtual laboratories with procedural capacity, the possibility of acting or responding with a procedure (both autonomously and in response to a student's action), further enhances the immersion experience. In this line, work has been carried out on the development of a system based on an electrochemical structural model that simulates the polymer membrane fuel cell at a low cost, the Unreal Engine video game engine has been used to develop interactive simulations of direct current circuits and, in general, the advantages of virtual laboratories in engineering education have been described.

4.2. Smart mentoring and skills development

The implementation of AI-based intelligent tutoring makes it possible to offer personalized services to engineering students, support them throughout their learning process, and manage the development of technical and soft skills. These systems act as intelligent tutors by allowing the student to communicate in a natural language with the system through natural language processing and the system to offer real-time support. They allow students to be guided using gamification techniques, making interaction with the system more enjoyable and fun. They are an excellent tool for large-scale attention in courses and syllabuses grouped by different institutions, improving access to programs and courses where the number of students exceeds the capacity of face-to-face attention of universities.

However, they must be managed by groups of teachers who intervene in the pedagogical design of the course or subject and thus ensure the quality of the support provided and the adequate development of competencies. Their participation ensures the quality, seriousness and emphasis on the development of soft skills that are required in the increasingly demanding service and technology industries. They are also an innovative tool, in terms of the way they impact the educational ecosystem, both for students and for the institutions that supervise the Offer.

4.3. AI-based formative assessment

Evaluation is one of the fundamental pillars of the educational process and requires special attention from teachers. The implementation of AI in education offers great opportunities for the automation of formative assessment, which considers the continuous generation of information and feedback for students that allows for deeper and more meaningful learning. Technological advances make it possible to offer useful feedback in the evaluation of tasks and exercises, from choice and multiple choice problems to essays, allowing the student to know their performance in real time and correct them before the formal delivery for grading. AI tools can also help generate assessment questions in quizzes, exams and accompanying or sustaining assessments, contributing to a process with a correct and appropriate diversity of items.

Therefore, AI applications will offer support for an adequate evaluation of students in tasks that allow grounded and autonomous learning. In addition, the generation of intelligent tutoring environments enhances the design of learning activities that require greater effort, reflection and processing, and that are therefore more likely to be initiated, overcoming the dangers of abandonment that they entail.

5. Implications for the training of electronic engineers

Methodological approaches achieved with AI and its capabilities require rapid adaptation in the training of electronic engineers. The proposal for the design of courses, collected on the basis of data on the effective or potential use of AI tools and in their interaction with the teaching-learning process, must include topics such as ethics, safety and responsibility in the use of AI in a transversal way to the training plans.

The analysis of the literature allows us to identify requirements for the adoption of AI in university education. Currently, a large technological gap limits equity in access to quality education. On the one hand, developing countries have few resources and adequate infrastructure to teach future professionals to read and write in the use of AI. On the other hand, in those countries where access to AI technology is widespread, universities require the development of infrastructure and adequate investment in human resources to optimize their response to growing demand. The introduction of uncontrolled algorithmic biases into AI can lead to harmful decisions for its users. For this reason, it is necessary to establish training programs focused on the ethical, security and responsibility principles of use in the development of capacities for the management of AI in cyberspace, and to propose governance frameworks for these technologies.

5.1. Data-driven curriculum design

The data generated by the use of AI tools in education allows the design of programs and specific plans to be optimized. The analysis of the traces left by students on learning platforms offers valuable information for the design of online pedagogical and training practices. In the context of a Colombian university, the design of Mathematics courses within a program in Systems Engineering has been addressed. The goal is to guide the methodological design and selection of tools to achieve the learning outcomes defined in the syllabus and the practices grounded in Bloom's taxonomy. In this way, it is guaranteed to meet the educational expectations of the institution and the students.

Having a clear ethical framework on AI, security and privacy at the local and global level, with guiding principles and a governance framework, is becoming relevant in the face of the adoption of technology. Public universities in Colombia have joined in an agreement on the responsible use of AI in the academic field, based on the Montevideo Declaration on a Sustainable Digital Future, which enunciates the principles of justice, security, privacy, inclusion, development and respect for life. In line with strengthening the social and ethical aspect in the training of engineers, policies and protocols related to AI have been designed in the academic field that emphasize aspects of equity, inclusion and safety.

5.2. Ethics, safety and responsibility in AI

The impact of artificial intelligence (AI) on the digital society raises the need to develop responsible technologies that take into account social and security issues. Therefore, the design and construction of AI systems require the implementation of principles, frameworks and good practices that enhance security, data protection and privacy, ensure the use of real and unbiased data, and promote sustainability and social well-being, in order to give the standard an ethical dimension. Under this premise, electronic engineers must be trained in principles, governance frameworks, and standards related to the design and construction of AI systems, as well as in the critical evaluation of AI solutions developed by third parties.

Training in ethics, safety, and responsibility in artificial intelligence throughout a curriculum cannot be limited to a single subject. The impact of AI on today's digital society is driving the creation of new standards and governance frameworks that guide the design and construction of responsible technologies. The guidance developed on 29 May 2020 by the Commission of the European Union, the High-Level Expert Group on Artificial Intelligence, the Council of the European Union and the European Parliament focuses on the impact that AI can have on people's lives.

6. Challenges, gaps and risks

The adoption of AI in higher education is marked by inequalities that can harm the most vulnerable groups. In addition to requiring appropriate access and use conditions in these technologies, it is crucial to mitigate algorithmic bias and ensure privacy and data protection.

The technology divide, which differentiates those with access to more advanced infrastructure and human and financial investment, is the most evident in relation to the adoption of AI solutions. Tools like ChatGPT are far from reality in certain institutions and, due to their generalist nature, are not always useful in those contexts. However, the development of AI models that use a limited dataset makes it possible to offer a satisfactory service even with limited resources, as shown by several studies.

While not all advances in AI lead to an increase in inequalities, it is important to visualize the direction of current trends and avoid larger gaps. This is, for example, the intention of a recent research that develops a global map of access to cloud computing infrastructures. On the other hand, algorithmic bias is a critical problem, both in the use of generalist tools and in the development of specific systems. Biases are recognized in many areas, such as the storage of image generation models since, depending on who has supplied it, it can present a distorted view of the racial, ethnic or sexual profile of the people or situations shown. For this reason, the requirement for an AI governance approach is not a distant or futuristic matter.

6.1. Technological gap and access

The growing adoption of AI tools in education has created a technological gap in access to these services, especially in economically constrained regions. In Colombia, a detailed analysis of the conditions of access to the Internet and computer devices in households shows that only slightly more than 58% of households own a computer, compared to less than 40% in strata 1 and 2. Consequently, universities face the challenge of having the technological resources to take advantage of the benefits of AI in teaching and learning processes. In addition, implementing learning environments with AI requires students to have adequate connectivity and equipment. Otherwise, access to higher education would be limited to those who do not have the conditions required to benefit from AI in their training.

As the use of AI expands, algorithmic biases become an issue of increasing importance. Predictive models often tend to replicate existing social inequalities, perpetuating the violation of the rights of diverse groups, whether by race, gender, or other aspects. For this reason, it is recommended to include in the curriculum of electronic engineers, as well as in other careers, training in ethics, biases and privacy, mentions on the global governance of AI systems, and the way in which algorithmic biases are generated, as well as to enhance sensitivity to these problems.

6.2. Algorithmic biases and transparency

The use of algorithms may contain biases that reduce the quality of prediction in AI. Especially in the case of facial recognition systems, a bias can arise from the low number of photos for the training of some of the classes, which decreases their recognition performance. Another important aspect is the lack of transparency in the operation of the algorithms; if you don't understand how an AI thinks, it will be impossible to disable an effect that can lead to an erroneous prediction. Transparency in AI is intimately related to the determination of bias within algorithms.

Analyzing how algorithms behave in other people's predictability requires some explanation for it. In the academic field, there are several strategies that allow improving and guaranteeing the transparency of an algorithm. One of these is the combination of several algorithms (known as Ensemble), another is the modelling of a not-so-opaque algorithm and then establishing an explanatory model based on it that allows us to predict the behaviour of the first.

6.3. Privacy and data protection

The increasing digitalization of the world and the widespread use of AI raise new questions about privacy and data protection. The ability of computer systems and online platforms to record, store and analyse large volumes of personal data (big data) requires protection mechanisms. The implementation of these mechanisms and their adoption at the global level do not occur simultaneously. Therefore, new technologies present dangers for individuals and for society as a whole; One of these dangers is the increase in power concentrated in large technology corporations, which appropriate large amounts of personal data and use it in an almost hegemonic way. This use raises serious questions about the ethics of the decisions on which they are based and about the possible effects of their use for political marketing.

In the field of education, concerns about the privacy of student-related data and how that information will be used is present in the design and development of many applications. The more "intelligent" an automatic tutor is, the more data it generates about the student, his way of learning and behaving. Again, both the design and the implementation should offer guarantees of privacy and protection against non-consensual use or processing.

7. Case studies and experiences in Colombia

The case studies and experiences in Colombia cover two areas. First, universities that have begun to implement AI-based tools are identified and some pilot projects in development are described. Then, the repercussions of the incorporation of these tools in the curricula of a series of subjects are analyzed and emphasis is placed on subjects in the area of electronics.

The proliferation of Generative AI tools has allowed their use in learning and teaching in several universities and has led to the development of pilot projects aimed at evaluating their effectiveness and functionality. In the Colombian context, the Universidad del Norte has been the first to adopt ChatGPT for teaching purposes. This university and others (such as the University of Afid and the University of St. Bonaventure) have formally sent their students guidelines and recommendations for the use of Generative AI. On the other hand, articles have been published in academic circles addressing initiatives, drivers, limitations or challenges associated with the integration of ChatGPT in the learning environment.

7.1. Universities and pilot projects

Universities, both in Colombia and in the world, must adapt to the trends posed by artificial intelligence. In this sense, some institutions already train teachers in the use of platforms such as ChatGPT and implement these tools in their daily practice. Several pilot projects seek to investigate the possibilities of ChatBots to improve student learning. In addition, learning environments are being designed in which virtual reality technology is incorporated to take advantage of the laboratories remotely, and others that combine the use of ChatGPT and AI players in the development of monographs, as well as in the development of soft skills such as critical writing.

An example of the use of ChatGPT in pilot projects is presented at the University of Medellín, where a graduate student in technology management was asked to implement a ChatBot on Discord that had a role similar to that of a remote tutor. It was an academic exercise that sought to evaluate how these tools could be integrated into teaching-learning processes, considering the safety and good use of generative AI.

7.2. Impacts on specific electronics curricula

Efforts to integrate artificial intelligence into electronic engineering curricula have concentrated in the area of electronic systems design and planning, rather than in the fundamental disciplines. Three of these initiatives focus on the research of specific lines or areas of systems design, using learning analytics data as input; have identified and prioritized courses that students find critical; and are evaluating trajectories based on the inventory of competencies related to ethics, safety, and responsibility in the use of AI, using governance frameworks as design input.

A pilot has been implemented in order to show a group of students their progress towards selecting an area of concentration in electronic systems design. On the other hand, the Universidad de los Andes has experimented with the design and implementation of an intelligent course in which students can travel in different routes, obtaining requirements indicators before each module and following a peer-guided learning approach.

8. Implications for academic policy and management

The development of competencies in the pedagogical use of artificial intelligence tools is necessary for the initial and in-service training of university teachers. The development of competencies in the pedagogical use of generative AI tools is necessary for the initial and in-service training of university teachers, through training programs that validate criteria for the implementation of AI in university environments.

Technological infrastructure and investment management are crucial for the use of generative AI as a support or complement to any of the stages of the training process. The continuity of the support or complement that these new tools can offer to the educational process, in any of its stages, will depend to a large extent on the technological infrastructure of each institution and its investment capacity to adequately equip it. Thus, the investment plans of universities must consider and prioritize the incorporation of the necessary infrastructure that guarantees accessibility for all students. The access gap between high and low quality students, which is already evident in Colombia, can widen even more and a mapping is urgently needed to show the magnitude of this inequality in access to AI tools.

8.1. Teacher training and professional development

The challenges arising from artificial intelligence in higher education require the training of new teachers who are capable of carrying out adaptive and quality teaching. The initial training of teachers, as well as their continuing education and professional development, are places where the necessary competencies must be prepared to be able to effectively integrate the new technological models that are emerging in the teaching and assessment of students in universities. Recommendation systems are an advanced example of the capabilities provided by AI and, combined with unstructured data analysis techniques, can offer new alternatives to support the development of skills in a foreign language with an automated tutor.

On the other hand, generative AI solutions that allow the creation of videos, Power Point presentations and writing in the form of a summary, article, story, essay or answer to a test in a way adapted to the student's level, helping in their study routine and at the same time becoming an opportunity for learning in the field of response formation or in the teacher's evaluation model.

8.2. Infrastructure, investment and sustainability

The use of artificial intelligence in university teaching requires adequate infrastructure and management, in particular in the following areas: provision of sufficient and sustainable technology; alignment of technological, human and financial resources; development and maintenance of pedagogical materials; funding of relevant research projects; and promotion of technical-pedagogical collaboration between professionals from different areas. Investing in technological infrastructure is necessary, but not sufficient, since guaranteeing adequate and sustainable access to technological tools in the classroom also requires, on the one hand, the definition of teacher training plans – undergraduate and postgraduate – aimed at developing the necessary skills to integrate AI into teaching-learning processes; and, on the other hand, the adaptation of institutional development plans, so that all resources – scientific and academic, technological and financial – are aligned with the incorporation of artificial intelligence in teaching-learning processes.

The development of technological infrastructure must also go beyond the simple accumulation of equipment. On the one hand, it is necessary to promote the creation of a culture of use of technology and close the gaps in its use. On the other hand, work must be done to create the requirements of these Hot Labs, both in our engineering training programs and in the support program of the universities, so that the use of AI enhances active learning and not just a more playful and theatrical evaluation of knowledge.

9. Conclusion

The above overview indicates that artificial intelligence has the potential to contribute to the pedagogical transformation in the training of electronic engineers, aligning itself with the demands, opportunities and challenges of the new digital era. The directive of the curricular innovation process begins with the design of the mesh based on analytical data related to the demand of the labor market after the study plans, business plans, AI industries or companies. Another significant aspect is the prioritization of ethical, safety, and responsibility principles in the use of AI. Factors and possibilities of the use of AI in virtual education and the use of technology for formative assessment and tutoring are also pointed out as guidelines for change to be taken into account. Finally, the conclusion for the training of electronic engineers is that artificial intelligence enhances learning processes, but does not replace them.

The approach to the issues, including the reflection associated with their social and cultural reality, becomes fundamental. Hence, future work should address the impact and use of AI technologies in assessment systems and in the creation of co-assessment systems between students based on AI technology, as well as the characteristics and functions necessary in the configuration of an AI-powered intelligent tutoring system, all of them in the field of distance learning and for all fields of knowledge.

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