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Disruptive technologies in the university curriculum: use of artificial intelligence

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ABSTRACT

The so-called "digital era" is synonymous with the transformation of every aspect of human life. This transformation is given by the development of new technologies that modify the way humans communicate and cooperate. Now, it can be said that formal education, compared to other economic sectors, is lagging in the integration of novel technologies in higher education curricula, especially in terms of implementing artificial intelligence (AI). The objective of this research was to conduct a systematic review of the scientific production related to the incorporation of artificial intelligence as a disruptive technology in the university curriculum. It was carried out using a qualitative approach based on a systematic review. The review showed a greater scientific production between 2022 and 2023; it was also evidenced that, as a technology, artificial intelligence has become a disruptive element thanks to its ability to change the role and work performed by teachers, students, and educational institutions. Consequently, the university of the future urgently needs to plan, design, develop, and implement curricula that include artificial intelligence, with the purpose of training better professionals, capable of acting effectively in a technological and productive environment.

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1. INTRODUCTION

Technological advances have taken different spaces in society, managing to fulfill functions that surpass human capabilities. They have not only changed the way man lives and acts but have also greatly influenced the way we educate. The educational sector, especially university institutions, is aware of the social demands for the generation of innovative models capable of satisfying the demands of their students and consequently of society in general. Faced with this reality, their response must be innovative, flexible, and attractive in order to maintain the educational demand they have traditionally served [1].

It is necessary to highlight how the digital transformation experienced worldwide and accelerated by the COVID-19 pandemic represents. At present, a key and essential element for the education sector, especially because digitization and the incorporation of new technologies are no longer an option since it symbolizes a requirement that is almost impossible to avoid [2]. Reflecting on its importance involves understanding that this transformation brings with it a set of actions in which new technologies are integrated into all areas of an institution, in order to optimize the training provided through the use of technology [3].

Amid these changes generated by new technologies, artificial intelligence (AI) made its appearance, which, although it is not a new term, has changed the way of seeing and executing the methods and contents of the higher education curriculum. Due to this situation, AI is seen by several authors as a disruptive technology capable of changing the traditional conception of the academic work of both teachers and students [4]–[6] as it allows teachers to choose important learning content on learning platforms for each student and according to their personalized needs. Despite the various educational benefits offered by the use of AI through its multiple tools, its incorporation into curricula has been gradual and has generated quite deep debates on the process required to include it in the curriculum, specifically in the university curriculum. The study on the incorporation of new technologies in education is not recent, however, it continues to be an interesting topic to analyze because the challenges faced have not been easy to overcome.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) [7] stated that AI currently faces difficult challenges at the educational level; however, its incorporation in this sector will make it possible to develop quite innovative teaching and learning practices. It also stresses that rapid technological advances, as has happened in the case of AI, inevitably involve innumerable risks and challenges that the different policies and regulatory frameworks by which Member States are governed must overcome in order to overcome them.

The debates have not only taken place in organizations such as UNESCO or in the governing institutions of education present in the different nations but also in the universities themselves. In this area there is no consensus among intellectuals and educators regarding the considerations on the subject since most of them do not know the characteristics of AI and its applicability; in addition, few institutions have the infrastructure and resources to make use of AI in the academic area [8]. However, despite these shortcomings, the constant technological changes urgently require curricular adaptation in the curricula; such adaptation requires that AI be included in each disciplinary field.

Through the meeting of AI and academic programs, the student will be able to provide intelligent solutions to real-world problems [9], [10]. The strategies, tools, expertise, and training provided by AI need to be adopted more broadly at the academic level in order to prepare students with "applicable portfolios, professional planning, and skills to apply their discipline-specific knowledge and have an even greater impact" [11]. Previously, AI was seen as an element of fiction, an unattainable technology that could only be found in movies or in scientific technology laboratories; however, the dizzying social changes experienced over time have changed this conception to transform it into something more tangible and necessary [12]. Hence, its impact is evident throughout society and in all its sectors, especially in education. Several recent studies [13]–[15] showed that the presence of new technologies requires that the teaching-learning processes be optimized, since "education is not a product, it is a process, where learning goes beyond the simple acquisition of knowledge" [6]. In other words, the improvement of educational processes is not simply a matter of implementing new technologies but also implies their evolution through constant training of both teachers and students.

Currently, pedagogical processes go beyond the mere fact of acquiring knowledge, for this reason, AI as a disruptive technology represents a tool with great potential because the systems on which it is based favor personalized learning according to the needs and interests of students [16]. Based on this premise, it is necessary to highlight that in recent years international organizations have observed the relevance of the use of technology in education, focusing their efforts on the digital literacy of all educational agents, so that they are able to introduce technologies in school environments. However, for this to happen, a curricular change is required in which student achievement prevails. Achieving this goal will be possible because the use of digital platforms allows changing the speed, the material, and the complexity of the curriculum, to offer optimal and experiential learning [16].

Disruptive technologies refer to a group of technologies that have certain characteristics that are completely new and that people are generally wary of using [4]. At the educational level, innovation in learning implies a disruption, since it creates transformative effects by using a network of new technologies that favor a space for transformational learning, collaboration, thinking, diversity of learning tools, and open education. These resources overcome the paradigm of traditional teaching for both students and teachers.

There are several technologies used in higher education that are considered disruptive, for example: online learning, competency-based education, virtual reality, collaborative platforms, and AI. These allow the educational process to be more convenient for students, as opposed to the conventional educational methods or practices offered in universities [17]. AI in university education has much to offer, especially in terms of moving towards digital disruption, and although the digital transformation of education is perceived to be near, it has not yet happened [8].

In the midst of globalization, AI is expanding around the world at an accelerated pace, however, its implementation in the different curricula for university students is quite scarce, especially in areas such as science, technology, engineering, and mathematics [6], [12]. Similarly, recent studies on the subject have

shown that AI literacy is neither equal nor sufficient for all students entering university. This aspect is quite significant to mention because with the incorporation of AI into the curriculum it is possible to help achieve this goal [13], [15].

The importance of incorporating AI into the university curriculum has been considered and recognized by different international organizations, including UNESCO, which considers that implementing AI will have a significant impact on curricula and pedagogy. For this reason, the Beijing Consensus urges States to take advantage of the potential offered by AI to support learning, teaching, and evaluations; clarifying that human interaction should not be relegated or replaced by machines [7]. In other words, quality education requires human intervention, established through the active engagement of teachers.

Based on the explanation, the purpose of this study is to carry out a systematic review of the scientific production related to the incorporation of Artificial Intelligence into the university curriculum in the Scopus and Web of Sciences (WoS) databases. Its importance is based on the need to show the evolution of the literature on the subject, especially the challenges currently faced by AI in higher education, as a tool that favors educational quality. This aspect shows the scientific element analyzed since it constitutes an extremely important research topic due to its constant evolution at both educational and social levels. According to this objective, the following research questions were identified:

i) How has the scientific production of AI as a disruptive technology evolved according to year, language, authors, journals, and countries?
ii) What research has been published in the academic world on the incorporation of AI in university curricula?
iii) What type of research predominates in AI publications?

According to the demands and experiences that, during the last years, have increased concerning the use of AI in higher education, it is essential to know the most recent studies, as well as their findings, in order to improve the future of education and overcome its limitations. In this sense, a systematic review of the presence of AI in university curricula will help to synthesize the contributions that have been generated in this field [18].

2. METHOD

A systematic review with a qualitative approach was conducted in order to compile the most important articles published on AI used as a disruptive technology in the university curriculum. The elements of the PRISMA systematic review and meta-analysis report used in the selection of articles were taken into account for the review [19], [20]. This methodology was selected for the search strategy because it is widely endorsed and adopted as a guide for systematic reviews [20]. Systematic reviews are considered a very appropriate tool to systematically assess and evaluate a certain body of literature, which has guidelines and criteria for the analysis of publications in relation to the different variables involved, the area of knowledge, or the year of publication. The validity of these investigations is evidenced and demonstrated by the number of studies carried out that use this technique [21].

Using this methodological approach will help to identify and comprehensively analyze previous and current studies related to this topic, as well as to identify the challenges and opportunities that AI faces in this field at the educational level. Answering the research questions posed required a systematic review of the following databases worldwide: WoS and Scopus. They were chosen because they both gather a vast scientific production that meets rigorous quality criteria [22].

The search described in Figure 1 was carried out taking into account the title, keywords, and abstracts; this process yielded a total of 1,800 documents up to August 17th, 2023, basically, all of these were articles. Different selection criteria were applied to these 1,800 documents according to the purpose of the study; the general description of the search protocol is summarized in Figure 1 [19]. This procedure was executed in order to improve the sample of documents, thus reducing the number of publications and obtaining the most important ones. Also, the final search string was TITLE-ABS-KEY (Artificial intelligence OR Disruptive technology) AND TITLE-ABS-KEY ("university curriculum " OR " higher education " OR " Disruptive technology") AND PUBYEAR < 2023 AND PUBYEAR > 2015 AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re")). The obtained keyword network was displayed on a map using VOSviewer software.

In the first screening, the documents were considered taking into account that their titles, abstracts, and keywords had the terms “artificial intelligence”, “university curriculum”, and/or “disruptive technology”. The reason for this choice was to relate the descriptors to the indexing disciplines most related to the field of education and technology. The application of this aspect reduced the number to 1,050 documents. Subsequently, the inclusion was focused on articles, excluding books, book chapters, and conferences, thus obtaining 750 documents. Similarly, only those articles published in indexed journals, between 2015 and

2023, in English and Spanish, were considered. Finally, once the inclusion and exclusion criteria were applied as shown in Table 1, the final inclusion was composed of 71 articles (41 in English, 30 in Spanish).

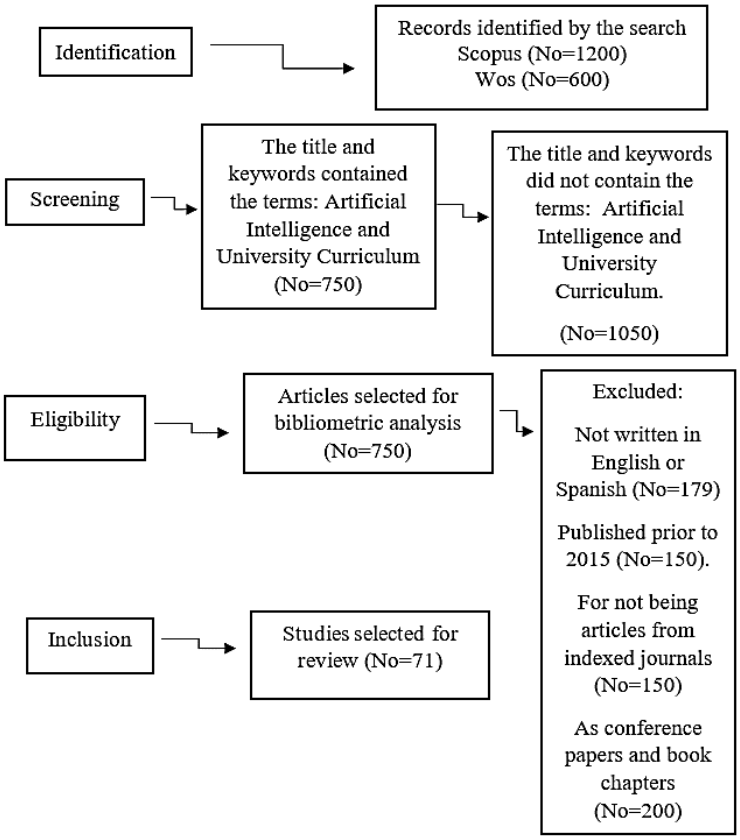

Figure 1. Selection process for the review

Table 1. Study variables and inclusion/exclusion criteria

Criteria	Inclusion	Exclusion
Year	Between 2015 and 2023	Prior to 2015
Subject area	Education and technology	Not pertaining to education and technology
Language	English and Spanish	Different from English and Spanish
Type of publication	Indexed Journals	Book chapters, Conference papers, Conference proceedings

3. RESULTS AND DISCUSSION

Based on the questions posed, we proceeded to interpret all the documents found in order to determine their trend. The search in the databases generated 1,800 documents on the subject. The papers carried out in the area of education and technology, disciplines in which the terms AI, disruptive technology, and university curriculum appear in the title and keywords between 2015 and 2023 were examined. The search was conducted in Google Scholar and Crossref.

Figure 2 shows the network of keywords contained in the articles reviewed. The colors presented in the network show the characteristics of a network node according to the predominant term. The colors show different groups and the size of the circles symbolizes the frequency of occurrence of the keywords. The distance between them indicates the existing correlation. It is possible to observe in the co-occurrence analysis of the main node, being AI, that terms such as “education”, “technology”, “statistics”, “e-learning”, “university”, “active learning”, among others, emerge; all these words are quite related since they serve as keywords to define and explain the use of AI at a higher level.

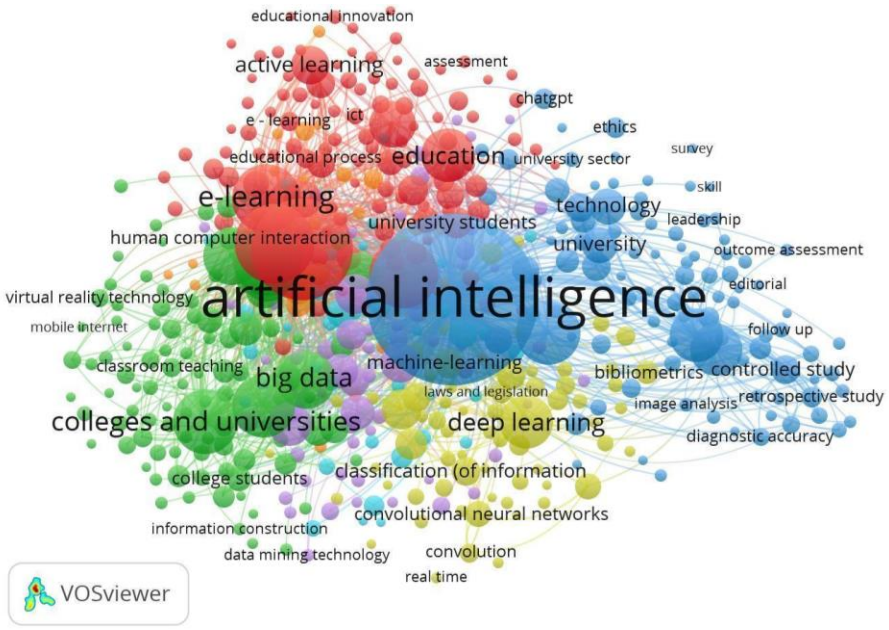

Figure 2. Network visualization for keywords

To answer research question 1, the study contexts of the articles were analyzed according to the year of publication, a database for interactions, and language. The results are shown in Figures 3 and 4. In relation to the search equation, in 2015, five articles were published on AI, at this time the term was more related to the education sector than to disruptive technologies. The same happened for the years 2016 and 2020, however, already for the latter year it was linked to the term "disruptive technologies". During the years 2017 and 2018, the same number of publications occurred, increasing a little during 2020. Finally, 2022 and 2023 showed the highest amount of scientific production on AI as a disruptive technology, evidencing the great interest of the scientific community in this topic as presented in Figure 3.

Concerning the databases used, Figure 4 shows the importance of these databases at the time of publication. According to the data obtained, Scopus, recognized worldwide for its impact, has published a total of 35 articles on artificial intelligence during the period studied. It is followed by journals indexed in both Scopus and WoS with 20 publications, and in last place is WoS with 16 scientific articles published. In terms of the predominant language of the publications reviewed, English stands out with a total of 41 articles, while in Spanish there are 30 documents as seen in Figure 5.

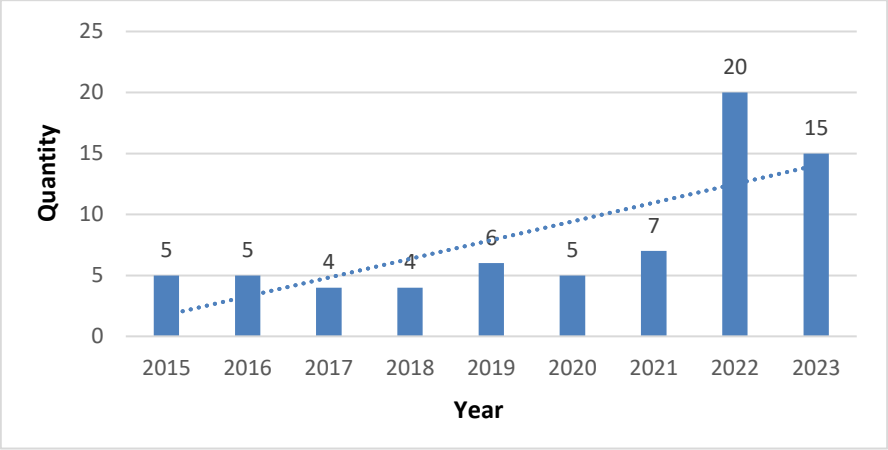

Figure 3. The number of publications on AI as a disruptive technology in the university curriculum in the period under review

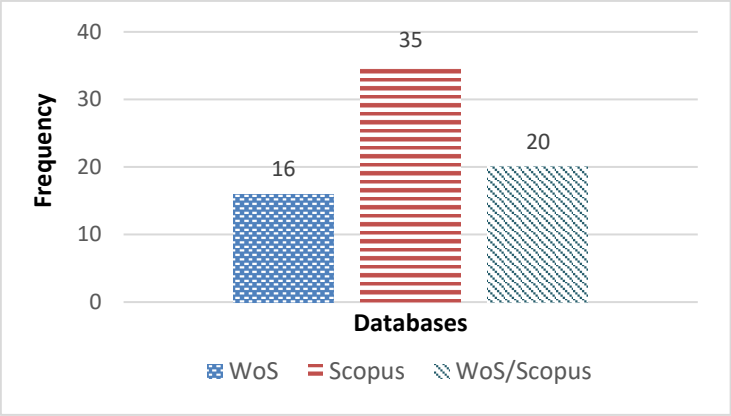

Figure 4. Database with the highest number of publications

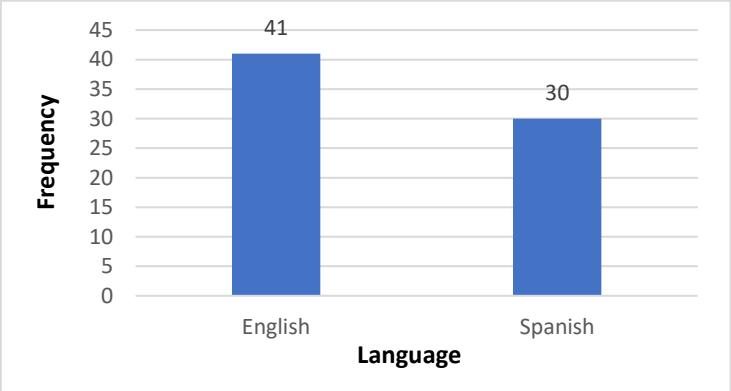

Figure 5. The number of publications by language

The review showed that there is a diversity of journals in both English and Spanish dedicated to the publication of articles on AI in the university context, as well as its intervention as a disruptive technology in the university curriculum. Among these journals, the following stand out: Hindawi Complexit (WoS-Scopus English), Salud, Ciencia y Tecnología (Scopus, Spanish), Radiology: Artificial Intelligence (Scopus, English), Computers and Education: Artificial Intelligence (Scopus, English), ACM Trans. Asian Low-Resour. Lang. Inf. Process (Scopus, English), and Revista Latinoamericana de Tecnología Educativa (WoS and Spanish). Answering the second research question, the results showed those studies that have been published about the incorporation of AI in university curricula, AI in education, and AI as a disruptive technology. Figure 6 shows the results of this question.

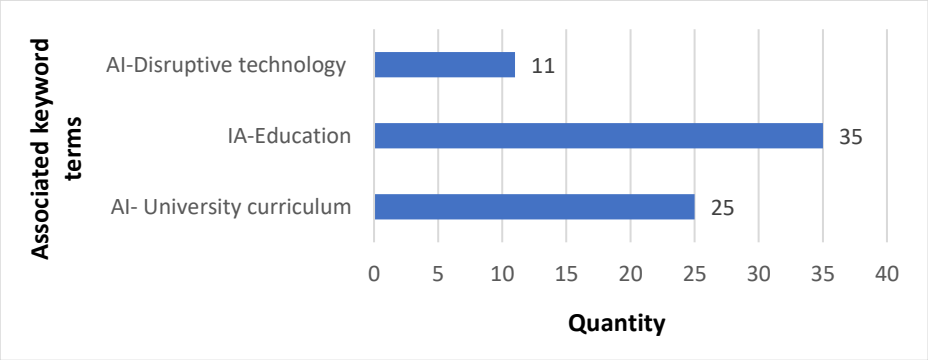

Figure 6. Number of articles according to associated keyword terms

Similarly, with respect to research question 3, the papers examined in relation to AI as a disruptive technology almost entirely evidenced a qualitative approach; of which, documentary research was present in 19 articles. Systematic reviews and bibliometric analyses with 15 and 9 articles respectively; 8 articles were mixed and 7 were reflective. The rest of the documents reviewed (13) did not specify the type of research developed in the study; however, their analysis showed that they presented a qualitative approach as presented in Figure 7.

Table 2 shows a summary of the articles examined [4], [6], [11], [23]–[35]; it shows the most significant and most valued data at the time of this review. The documents reviewed showed that AI has been defined as a series of systems designed to create human-like behavior in machines, ranging from perception, reasoning, and action itself [36], [37]. Furthermore, regarding its characterization as a disruptive technology at the educational level, AI has been presented as a powerful disruptive factor as it is capable of changing the role and work traditionally performed by teachers, students, and educational institutions [5], [6], [37].

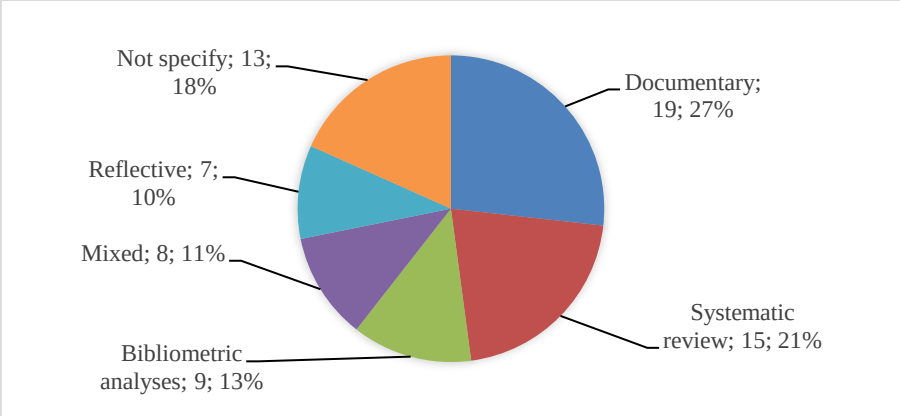

Figure 7. Research methodology implemented in the articles examined

Table 2. Summary of articles and journals consulted

Study	Year	Title	Source
[23]	2023	Artificial intelligence in innovation research: A systematic review, conceptual framework, and future research directions.	Technovation
[4]	2023	Artificial intelligence as a disruptive technology-a systematic literature review	Electronics
[6]	2023	The perception of artificial intelligence in educational contexts after the launch of ChatGPT: disruption or panic?	Education in the Knowledge Society
[11]	2022	Artificial intelligence and the disruption of higher education: strategies for integrations across disciplines	Creative Education
[24]	2021	Advancing a critical artificial intelligence theory for schooling	Teknokultura. Digital Culture and Social Movements Magazine
[25]	2021	Some aspects of AI-technologies in education	San Gregorio Magazine
[26]	2021	A review of artificial intelligence (AI) in education from 2010 to 2020	Hindawi Complexity
[27]	2022	Artificial intelligence and big data: the advent of new pedagogy in the adaptive e-learning system in the higher educational institutions of Saudi Arabia.	Hindawi Complexit
[28]	2017	Exploring the impact of artificial intelligence on teaching and learning in higher education	RPTEL
[29]	2023	What ChatGPT means for universities: perceptions of scholars and students.	Journal of Applied Learning & Teaching
[30]	2021	Exploring the impact of artificial intelligence and robots on higher education through literature-based design fictions	International Journal of Educational Technology in Higher Education
[31]	2023	ChatGPT: An ever-increasing encroachment of artificial intelligence in online assessment in distance education	Online Journal of Communication and Media Technologies
[32]	2020	Scenario-based approach to re-imagining the future of higher education which prepares students for the future of work.	Higher Education, Skills and Work-Based Learning
[33]	2020	Current and future artificial intelligence (AI) curriculum in business school: a text mining analysis	Journal of Medical Imaging and Radiation Sciences
[34]	2021	An artificial intelligence and multimedia teaching platform based integration path of IPE and IEE in colleges and universities	Journal of Intelligent & Fuzzy Systems
[35]	2020	Prerequisites for artificial intelligence in further education: identification of drivers, barriers, and business models of educational technology companies	Renz and Hilbig International Journal of Educational Technology in Higher Education

The various applications offered by AI in the educational field range from personalized learning, automated evaluation, intelligent tutoring, and learning problems detected in time [33], [34], [38]. Specifically, at the university level, it became evident that AI faces great opportunities, but also challenges, which must be addressed through the design of a new curriculum that allows students to appropriate the tools offered by new technologies to support their learning process. AI has been considered as a piece of educational technology and its potential has always been labeled as disruptive [4], [6]. This character has allowed AI-based technologies to generate significant educational advances for both teachers and students. Among the benefits offered by AI are the following: students can study at their own pace using AI instructors. Furthermore, they can learn independently and without a pre-established schedule. Finally, because it is a single-user system, the student would be more comfortable interacting with the teacher [13].

The results show that worldwide there has been a special interest in AI-based learning. Universities are rapidly adopting this technology to improve the quality of their teaching and learning processes [11]. In this sense, Wu *et al*. [34] point out that AI would serve as a complement and not as a replacement for human activity. This integration would result in an unsurpassed combination of talents.

Similarly, and apart from the applications, AI at the university level in Latin America has the following applications: predictive modeling, intelligent analysis, assistive technology, automatic content, and image analysis. On the other hand, both in higher education and in primary schools, virtual and augmented reality and voice assistants are among the most widely used AI applications. Their implementation requires curricular planning and supervision, specifically in the case of universities, to identify appropriate areas of use for AI, as well as coordination with infrastructure and technology to develop automatic learning.

The university needs a curriculum that formally integrates AI into the curriculum of each degree program so that there are curricular activities in which students can develop and learn to carry out AI projects in different areas of professional activity [39]–[41]. To this end, it is necessary to analyze the timing of its implementation, the areas of the institution in which AI could be most useful, the protection of student privacy, and, finally, to establish what the university intends to do by implementing AI [31], [38].

As we have seen, the application of AI in education is quite promising, as it includes, among other things, the personalization of learning, and the improvement of teaching quality. and resource management. It is also essential for universities to explore the various possibilities that AI can bring to higher education, promoting interdisciplinary dialogue and collaboration. On the other hand, the integration of AI in higher education is assured, due to the technological advances that have been deployed worldwide. However, such integration must go hand in hand with the teaching work, to establish a human-machine collaboration and an improvement of the totality of the systems to benefit teachers, students, and the institutional community. At the same time, it is necessary to promote the constant updating of the teaching staff in terms of didactic strategies, for which it is recommended to have technological tools as a way to awaken interest during learning.

It also became evident from the documents reviewed that large and small companies are currently using AI to drive an ever-changing economy; to achieve this, they require AI-trained workers and professionals [42]–[44] In many cases, this demand for professional talent comes from engineering or computer science schools, but their training is very limited. This reality requires concrete actions to meet the existing needs of a changing workforce, training students in various disciplines who are also competent in the application of AI in their discipline [45]–[47].

Regarding the implications for education, this review showed that AI promotes the integration of technology and informatics in the pedagogical process and research. These educational phases require adopting novel strategies that prepare students to use emerging technologies. For example, simulators are used in the healthcare field. However, they are costly to maintain, so a more viable option, such as virtual patients, is recommended. This learning experience potentially improves confidence and self-efficacy.

It is evident that in society there is a need for well-prepared professionals with updated knowledge in different areas. This must be fulfilled by the education sector since it is responsible for responding to this demand through a complete and updated curriculum, which undergoes a total reworking as well as the policies that regulate the educational field [26], [39]. However, although there is a willingness to use AI in education, there is no country in the world that is truly prepared for this kind of automation [48], [49]. This reality is known by rectors and organizations in charge of activating public policies at the educational level, which is why great efforts are being made to implement these technologies in curricula worldwide [50].

4. CONCLUSION

This study was carried out to systematically review the scientific production related to the incorporation of artificial intelligence into the university curriculum in the Scopus and WoS databases. The nature of the evidence supporting the results consisted of a literature review (documentary) and a series of

analytical procedures. Thus, the documentary nature and its analysis determined its relevance to answering the research questions posed. A systematic review was conducted on AI as a disruptive technology in the university curriculum during the period 2015 to 2023. The information provided by the articles reviewed shows that there is currently a real interest on the part of academics and governmental organizations to help the consolidation of AI in the educational field at the university level. However, a profound transformation of the university curriculum is required which favors a promising future for AI as a disruptive technology; understanding that it made its appearance to displace traditional education that, although it had excellent results in the past, has been relegated by the technological advances that are constantly occurring worldwide.

Artificial intelligence in the university field has a positive impact, as it allows the optimization of academic and therefore professional skills. The increase in the number of articles published during the year 2022 demonstrates this. In addition, many of these papers from the year 2021 onwards show the boom in research carried out as a result of the new reality experienced worldwide due to COVID-19 and which led the population to make use of digital tools, especially at the educational level.

Using AI favors the integration of learning with the particular characteristics of each university student; however, it is important to highlight that, just as there are opportunities in its use, there are also deficiencies that must be compensated by means of adequate control of this type of tool. The university education system urgently needs a rapid review of what is taught and how it is presented; this is with the purpose of making the most of technologies in the evolution of knowledge. In view of this and facing the challenges posed by disruptive actions generated in higher education institutions, it is necessary for them to redefine everything they offer to students, changing the way they deliver educational content, in other words, their processes in general have to be redefined.

The implications of the study are given by the characterization of the bibliographic production studied, which presents a sustained growth, with special incidence from 2021. This aspect shows how everything related to this topic will increase its presence in the scientific literature since AI and its social transcendence are in full expansion. Future studies can focus on bibliometric analyses of the different aspects included in the topic since the interdisciplinarity that characterizes disruptive technologies and their involvement in different branches of knowledge are of utmost importance for education.

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