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AI, in the Transforming of Education Throughout the World *

La AI, Transformando la Enseñanza y el Aprendizaje en las Ciencias y la Biología

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Abstract

The application of artificial intelligence (AI) has brought about significant changes in data processing, facilitating technological and scientific advancements with reliable results in the sciences. This digital technology aims to enhance laboratory work and information processing with speed, security, and efficiency. The objective of this research is to conduct a literature review and a scientometric analysis to understand how academic and scientific institutions, as well as researchers, have integrated AI into the processes of teaching and learning natural sciences and biology. Additionally, it seeks to examine the scope of research across different countries, institutions, researchers, and laboratories.To this end, a mixed-methods, qualitative and quantitative, exploratory approach was employed, conducting a scientometric analysis using the WoS and Scopus databases and utilizing the Tree of Science algorithm. This algorithm facilitates the organization of research and researchers into a tree of science, identifying the most relevant articles for this review.The findings highlight the impact of AI usage in the fields of science, industry, and academia, influencing educational, social, and cultural standards. Moreover, the challenges of integrating these technologies into pedagogical models and deeply understanding the processes inherent to AI are addressed. In conclusion, there is a current digital transformation accessible to researchers, with open-access platforms that activate a society conscious of the importance of digital information care and the reach of AI in the scientific domain.

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Keywords: Artificial Intelligence, natural science, biology, education, teaching, and lecture.

Resumen

El empleo de la inteligencia artificial (IA) ha revolucionado la entrega de información y el procesamiento de datos, acelerando los avances tecnológicos y científicos. Es crucial variar el suministro de información para obtener resultados confiables. Estos equipos de alta tecnología digital facilitan el trabajo en laboratorios y el procesamiento de información con rapidez, seguridad y eficiencia. Esta investigación explora cómo las instituciones académicas y científicas han integrado la IA en los procesos de enseñanza y aprendizaje de ciencias naturales y biología. Además, revisa la influencia de la IA en la exploración y comparación de investigaciones, analizando el alcance de la investigación a nivel mundial en instituciones, investigadores y laboratorios. Utilizamos una metodología cualitativa y exploratoria, realizando un análisis cienciométrico con WoS y Scopus. Mediante el algoritmo Tree of Science, concentramos las investigaciones y los investigadores más relevantes, optimizando el tiempo y asegurando un análisis preciso de las revistas más importantes en la investigación de IA en ciencias. Hemos obtenido resultados significativos en el uso de la IA en ciencia, industria y academia, impactando positivamente los estándares sociales y culturales. La transformación digital está al alcance de los investigadores, activando una sociedad consciente del cuidado de los seres vivos. En conclusión, la IA está redefiniendo el campo de las ciencias a través de la transformación digital.

Palabras clave: Inteligencia Artificial, ciencias naturales, biología, educación, enseñanza.

1. Introduction

The impact of AI in the natural sciences and biology represents a major technological breakthrough that offers new perspectives in research. As stated by the International Academic Program in "Tackling Global Education Challenges," AI has progressively improved the quality of research in these fields by providing essential tools for search processes, data analysis and information management. Digital literacy enables health sciences students to efficiently access reliable and up-to-date information, which supports continuous learning [1]. This process encompasses communication, collaboration, ethical considerations and systematic cultural changes to ensure an appropriate approach.

The cultivation of knowledge interest is vital for the development of AI-supported tools, and a cultural willingness to embrace change is essential. This transformative process requires assessing the competence levels of individuals in biology and natural sciences, similar to evaluating digital literacy. Furthermore, as suggested in [2], large language models like ChatGPT can reframe problems from fields such as probability theory and statistics, making complex concepts more comprehensible and enhancing interdisciplinary learning across various academic fields, including biology.Similarly, the importance of analyzing backgrounds, cognitive skills, and student interests in natural sciences and biology to facilitate adequate AI-supported research is emphasized in [3]. The intersection of synthetic biology and AI is explored in [4], discussing how these fields converge to define concepts such as life, cognition, artificiality, and natural phenomena, and their

theoretical implications in synthetic biology. They highlight the management of self-modification and self-replication technologies.

Despite resistance to change, including fears related to digital literacy and technological and cultural transformation, the primary objective remains to optimize studies and advancements in natural sciences and biology through technological means. This involves reducing research times and providing appropriate AI tools for information analysis, processes, investigations, and comparisons. Research goals in genomics, data analysis, transcriptomics, proteomics, machine learning algorithms, and molecular interaction studies are demonstrated in [5]. They illustrate how AI offers fundamental tools for genetic objectives, novel vectors, optimized experimental conditions, result prediction, and solution suggestions.

Historically, sciences have diverged in terms of predictive capabilities. The integration of AI and biology to produce autonomous systems by using AI to model intelligent capabilities for hypothesis formulation and testing through observations or experiments is discussed in [6]. This integration supports a structured platform involving algorithms, computational technology, digital tools, and even ChatGPT, thereby enhancing efficient, precise, reliable, and rapid information analysis.

In this research, we employed a methodology that began with a detailed search for relevant articles in renowned databases such as Scopus and Web of Science (WoS) using keywords. These articles were carefully filtered and reviewed to ensure their relevance. Subsequently, we generated several graphs and visualizations, which allowed us to draw our conclusions. To hierarchically structure and analyze the information, we used the ToS classification algorithm, which helped us identify key trends and relationships among the articles [7]. The application of the ToS algorithm has been documented in various fields of knowledge, as evidenced in the works of Alejandro Echeverri [8] and other studies [9], [10].

2. Methodology

Integrating AI with natural sciences and biology in research revolutionizes knowledge through qualitative and quantitative investigation, providing deep exploration into the use of tools in a rapidly changing world. This comes at a time when education is undergoing significant changes and information and communication technologies are supporting researchers in their investigative endeavors.Several questions arise from a qualitative standpoint: How does AI transform teaching and learning in natural sciences and biology? What is the impact of AI on research in these fields? How do the characteristics of AI facilitate reliable research in these areas? What is the cultural impact of AI integration?

In the realm of research, statistical analysis in qualitative studies of human subjectivity, such as attitudes, beliefs, feelings, and opinions, is proposed in [11]. This approach ensures

that the human condition and cultural aspects of communities are not overlooked in AI applications. Consequently, we have formulated specific and clear questions in our search for publications, utilizing digital databases such as WoS and Scopus. This search yielded the following results: Relevant keywords included AI, natural sciences, biology, education, teaching, and learning, resulting in 714 documents from Scopus and 342 documents from WoS. All records and cited references were downloaded and merged into a single dataset.
Once the searches were completed, the next step was to download the information for each document, including title, authors, abstract, keywords, cross-references and DOI. Figure 1 shows the overall process from search results to data analysis. Preprocessing proved to be a complicated task due to the differences in formats between Scopus and WoS. Text mining and web scraping were necessary to extract and normalize references from both datasets. Finally, the results were presented in two sections: the first, a traditional scientometric analysis using new techniques [12]; and the second, using the ToS metaphor to identify the main theoretical contributions [13], [14].

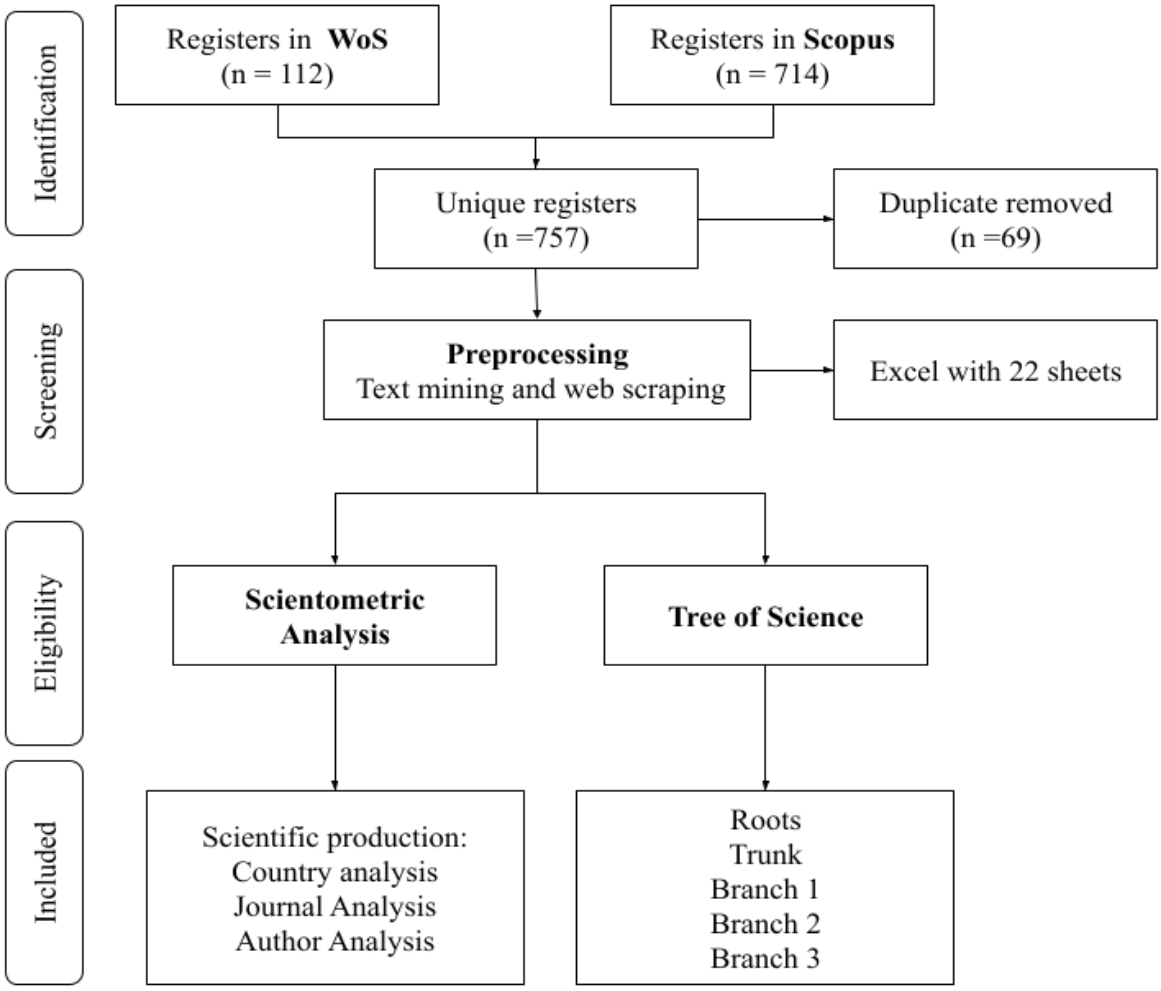

Figure 1. Systematic search flow, scientometric analysis, and application of the Tree of Science algorithm.
Source: Authors

3. Results

Considering AI as a transformative tool in natural sciences and biology research involves embracing a shift in global education that enables researchers to optimize search results and explore new fields of interest. AI is crucial in information retrieval, allowing efficient access to a vast number of articles that would otherwise be time-consuming.

Identifying the scientific community while considering temporality reveals unprecedented growth over the past ten years in research volume, number of researchers, publications, digital tools, technological transformation, data analysis, citations, knowledge-producing countries, and expertise. This research aims to contrast information retrieval results and continue to propose qualitative and quantitative studies on the use and implementation of AI in natural sciences and biology. There is a noticeable emphasis on rigorous methodology, supported by data networks, algorithms, and platforms integral to AI development worldwide.

Scientometric Analysis

This approach will allow us to analyze the quantitative study of science, technology, and innovation. Utilizing AI, we have undertaken the task of examining scientific and technological production that connects biology and the sciences with AI, taking into account social, cultural, and scientific impacts.

Through the scientometrics analysis, we have meticulously selected scientific documents to ensure accuracy. This includes indicators such as the number of publications, citations that demonstrate the impact of these publications within the scientific community, and insights into institutions, countries, and scientific journals.

These analyses, processed through AI, have provided us with impact indicators, network analysis, and an assessment of scientific policies, as referenced in [15].

Scientific production

Today, any researcher in natural sciences or biology can access a vast amount of biological data thanks to AI, as mentioned in [16]. This undoubtedly motivates the scientific community to explore knowledge through computational biology, which previously represented a delay in research processes. Patterns in biology can now be identified through technology, with new techniques constantly emerging to expand our understanding, utilizing technological and digital platforms for research purposes.

To validate the use of AI in biology and natural sciences, we must refer to Sweteler, who states that knowledge of a specific domain in the form of schemas distinguishes novices

from experts in problem-solving skills in research [17]. AI reduces process time and improves information management skills, providing accurate results and experimental evidence.

The importance of AI in information retrieval cannot be overstated; it must be accurately and carefully selected to achieve reliable analysis. In this regard, Valencia et al. proposes a web tool structured within the citation network, seamlessly integrating platforms like WoS and Scopus to algorithmically select classic, structural, and recent articles, thereby constructing a "science tree" [18]. Without AI, this search process would be tedious, and data processing would be time-consuming.

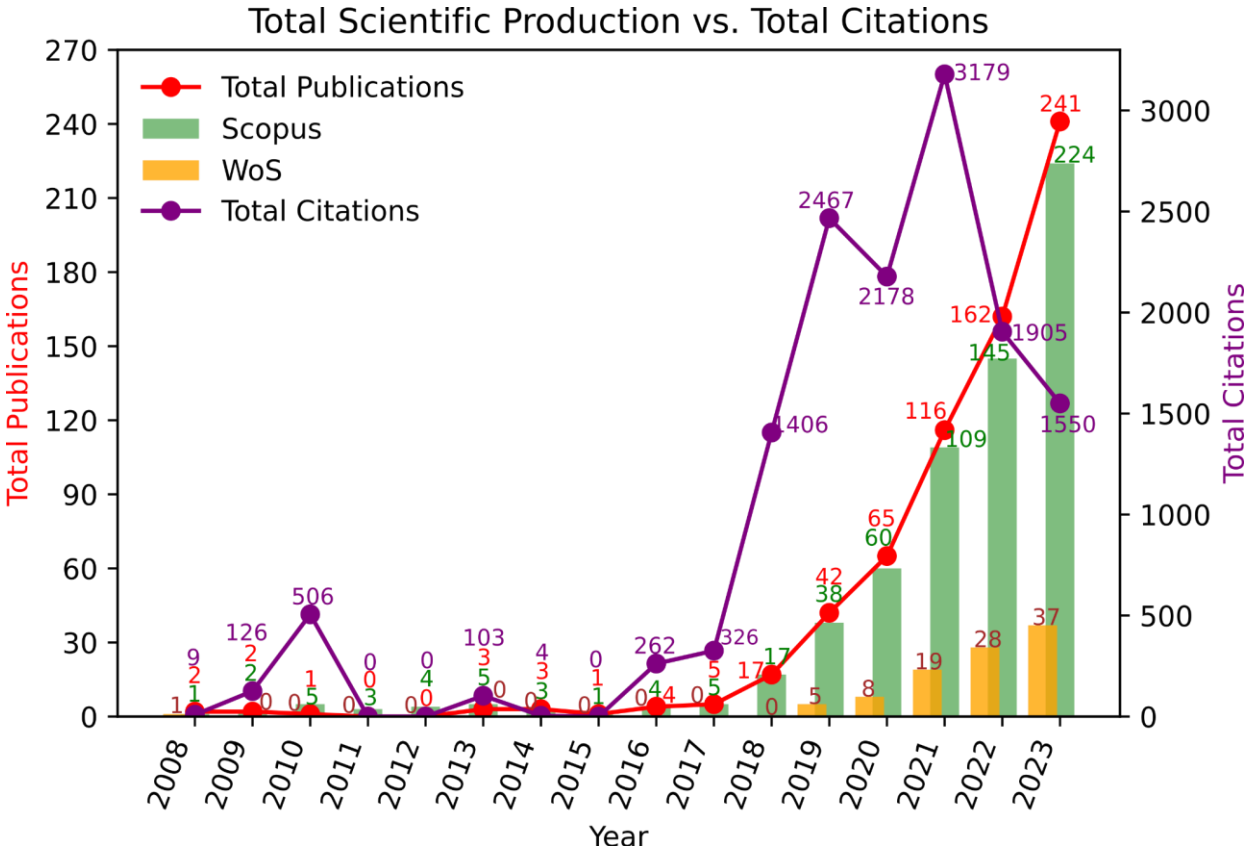

Figure 2. Scientific Production and Citations
Source: Authors

Figure 2 shows accelerated growth over the past five years, reaching 241 articles in 2023. This is due to the great interest in researching the impact of AI on education and how society is incorporating new technologies into daily life, and the profound impact they have on life [19]. Additionally, in 2021, the maximum number of citations was achieved, totaling 3,179, with the article by TJoa and Guan [20] being the most cited, with 650 citations. This article highlights the need to understand the algorithms used by AI, which in most cases are a black box to those who use these technologies. In 2019, there is a second peak in citations, with the article by Zawacki-Richter et al. [21] being the most cited (778 cites). In this article, the authors present a literature review showing that, as of that date, it is still

unclear how to pedagogically leverage AI in education. As a conclusion, they highlight a gap in the critical reflection on the challenges and risks of AI in education and the lack of connection with different pedagogical perspectives.

Country Analysis

Figure 3 presents the network production by country. The thickness of the links corresponds to the frequency of collaboration between countries, with the United States being the country with the highest collaboration and production. In addition, three main communities were identified, comprising about 16 countries working collaboratively. In the graph of nodes and links over time, it can be seen that in 2021 the number of links increases relative to the number of nodes, indicating the formation of a more connected community after 2021.

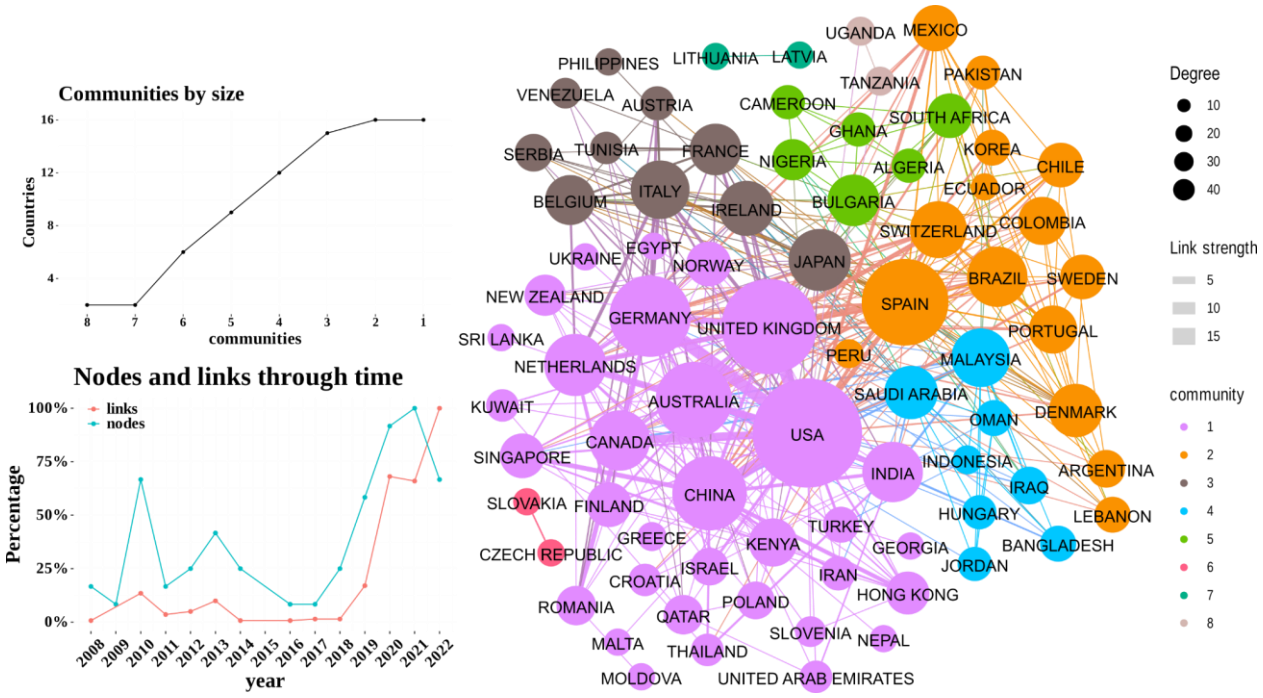

Figure 3. Countries Production and Collaboration
Source: Authors

China tops the list with the highest number of articles produced (235), with the highest production in uncategorized journals, followed by publications in Q1 and Q2 journals. The United States shows a similar pattern, with its highest production in uncategorized journals, followed by publications in Q1 journals. These two countries account for a significant majority of the publications, with approximately 48% of the total. The remaining 52% of

publications are mainly concentrated in India, UK, Canada, Germany, Australia, Italy, Spain and Turkey, as Table I shows.

Table I. Countries scientific production.

Country	Production		Citation		Q1	Q2	Q3	Q4
China	235	31.13%	2579	19.89%	46	41	19	7
USA	131	17.35%	2587	19.95%	32	12	9	2
India	41	5.43%	509	3.93%	3	3	1	2
United Kingdom	31	4.11%	635	4.90%	5	4	2	0
Canada	26	3.44%	441	3.40%	8	1	1	2
Germany	26	3.44%	1184	9.13%	6	3	0	0
Australia	17	2.25%	586	4.52%	2	2	2	0
Italy	16	2.12%	1075	8.29%	5	3	0	0
Spain	15	1.99%	92	0.71%	2	2	0	1
Turkey	13	1.72%	37	0.29%	0	0	1	0

China and Taiwan, addresses the challenges and roles of AI in education. It emphasizes the interdisciplinary nature of AI in Education and the need for collaboration among researchers from diverse backgrounds. This article highlights the need for personalized guidance and support in learning, which AI can provide by analyzing individual learning states and adapting to their needs. In addition, it outlines potential research topics and frameworks for implementing AI in Education in various educational settings [22].

As for China, its most cited article (298 citations) is a review[23]. This paper highlights the impact of AI and machine learning techniques on big data processing. This paper provides a research guide on the integration of AI in the sciences, aiming to help researchers gain a deeper understanding of AI applications and promote new developments in this field.

For its part, an article with a large number of citations (416 citations) by Italian researchers[24], deals with the application of AI in medical radiology. It discusses how AI can be integrated into the radiological workflow and the implications of this integration for radiologists. The article concludes that, although AI will significantly transform radiology, it will not replace radiologists. Instead, it will improve their efficiency and allow them to focus on higher value-added tasks, reinforcing their crucial role in multidisciplinary clinical teams. This analysis is critical to understanding how AI collaborations and applications across disciplines and regions are shaping the future of research and professional practice worldwide.

Journal Analysis

Through data analysis, we were able to identify the types of journals and the impact generated within the community. Naturally, we interpreted the relationships, H-index, and publication quartile, as depicted in Figure 4 and Table II.

Figure 4 shows two main groups of journals: in orange the journals related to informatics, computer science and engineering and in purple the journals related to health technology. The nodes and links through time shows that before 2019 there were more journals than citations in the same area and after 2019 there are more links between journals indicating that there is a consolidated community around this topic area.

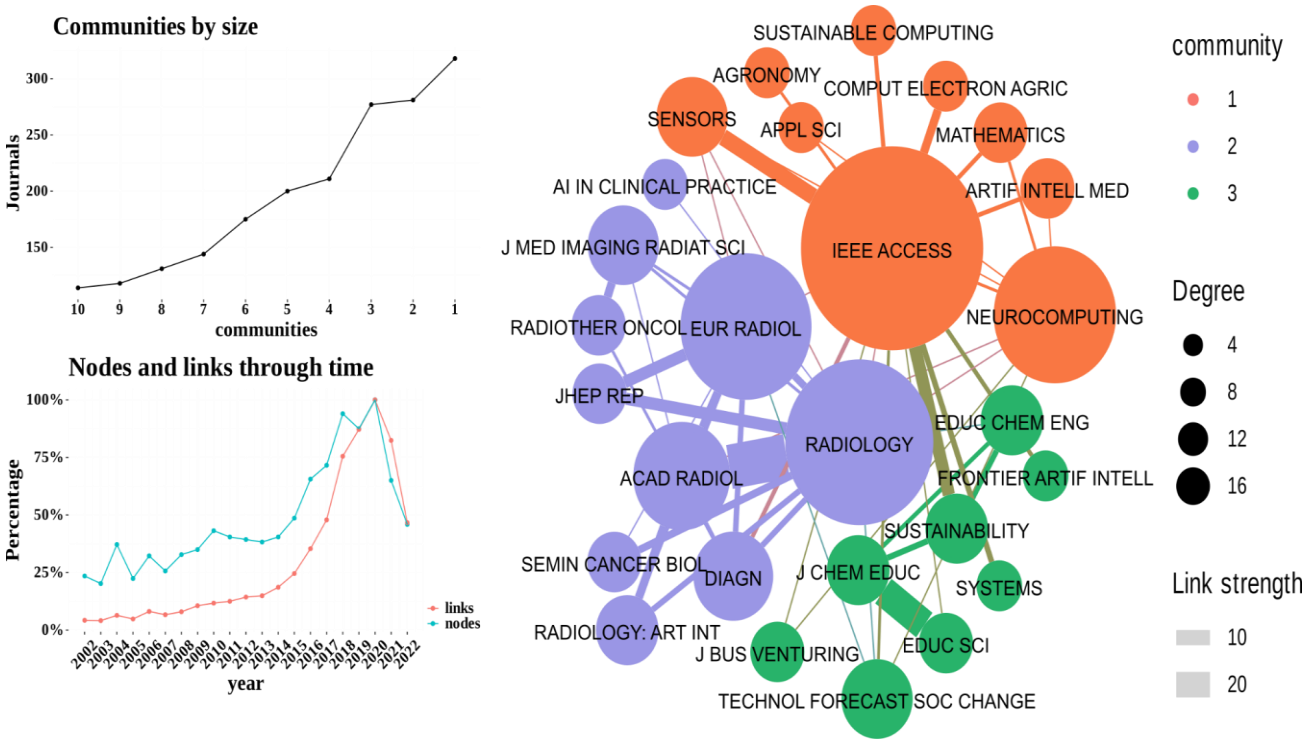

Figure 4. Journal Network Citations
Source: Authors

Table 2 presents the journals with the higher production. The most cited article in the Journal of Intelligent and Fuzzy Systems (with 24 citations) is an original study that presents the evaluation of a method for analyzing physical education teaching through the use of computer vision and AI techniques. This approach allows for a more accurate assessment of physical fitness [25].

An interesting article in the journal Education and Information Technologies (with 115 citations) focuses on the impact of educational technology on student learning, exploring how digital tools can improve comprehension and knowledge retention [26]. Detailed analysis of the article reveals that the use of interactive platforms and AI-based applications has proven to be effective in personalizing the educational experience, adapting to individual student needs and improving overall academic outcomes. This type of research underscores the importance of technology in modern education, highlighting its role in creating more dynamic and effective learning environments.

Table II. Journal production and impact.

Journal	Wos	Scopus	Impact Factor	H-Index	Quantile
Journal Of Intelligent And Fuzzy Systems	0	12	0.38	82	Q2
Acm International Conference Proceeding Series	0	9	0.25	151	–
Advances In Intelligent Systems And Computing	0	8	0	69	–
Education And Information Technologies	3	6	1.3	76	Q1
Journal Of Physics: Conference Series	0	7	0.18	99	–
Computers And Education: Artificial Intelligence	0	6	3.23	29	Q1
International Journal Of Artificial Intelligence In Education	0	6	1.84	62	Q1
International Journal Of Educational Technology In Higher Education	2	4	2.58	61	Q1
International Journal Of Emerging Technologies In Learning	2	6	0	46	–

Source: Authors

Author Analysis

Figure 5 presents the collaboration network between authors. In the graph of nodes and links over time, it can be seen that collaborations increase after 2019. This is consistent with previous results on international journals and collaborations. It can also be seen that there is a single majority community, indicating that it is a recent community from which different sub-communities will emerge. For now, it is a young community that is just beginning to establish itself and work collaboratively.

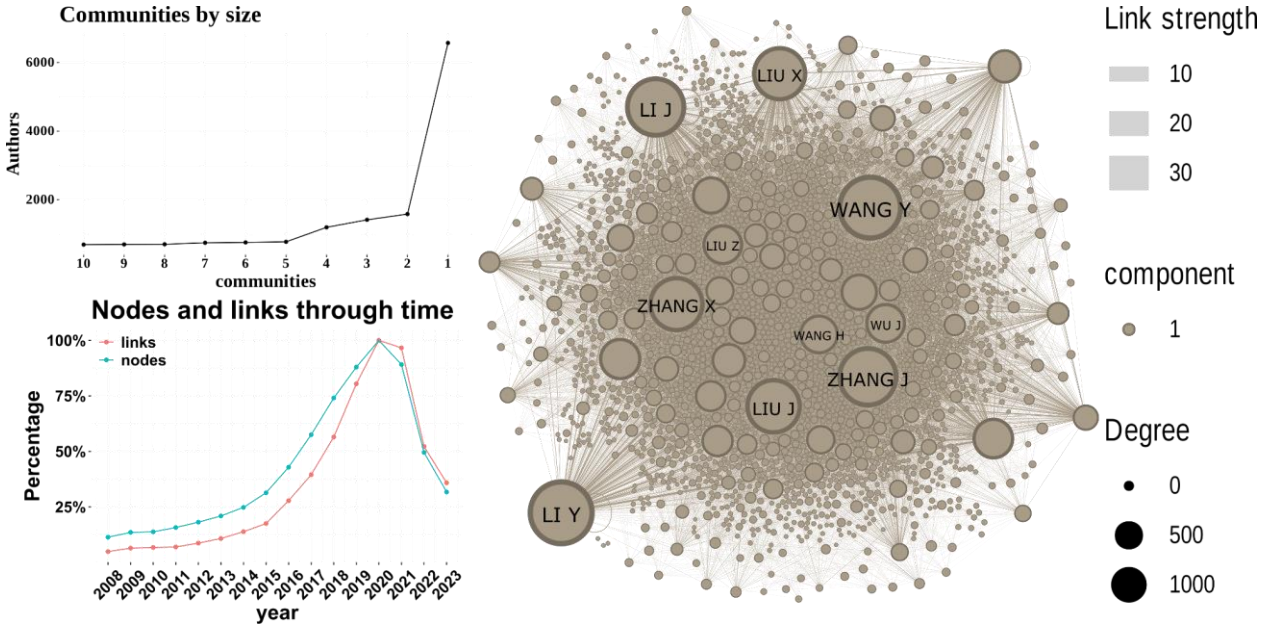

Figure 5. Author Collaboration Network.
Source: Authors

Table III identifies the most productive authors in the field. Li J, for example, has published several influential articles. One notable work by Li J addresses the mining of public opinion data in online education using fuzzy association rules. This study focuses on extracting meaningful patterns from large datasets to understand public sentiments and opinions related to online education platforms. By applying fuzzy association rules, Li J was able to create a model that captures the complexity and nuances of public opinion, thereby providing valuable insights for improving educational content and delivery methods in online environments [27].

Zhang X is another prominent author with a notable scientific output. In one of his articles, he explores the application of artificial AI technology in teaching psychology and pedagogy in colleges and universities. Zhang X highlights how AI can transform traditional educational methods by introducing advanced techniques such as deep learning and personalized learning. His research emphasizes the potential of AI to create more adaptive and interactive learning experiences, enabling educators to tailor their teaching strategies to the individual needs of students. Additionally, Zhang X discusses the role of human-computer collaboration in enhancing the effectiveness of teaching, suggesting that AI can act as a supportive tool that augments the capabilities of educators rather than replacing them [28].

Li Y has also made significant contributions to the field, particularly in the application of AI in education. In a comprehensive study, Li Y provided a content analysis of 100 papers from 2010 to 2020, examining how AI has been integrated into the educational sector and identifying emerging research trends and challenges. The study categorizes AI applications

into three layers: development (including classification, matching, recommendation, and deep learning), application (covering feedback, reasoning, and adaptive learning), and integration (encompassing affective computing, role-playing, immersive learning, and gamification). Li Y's research highlights future trends such as the Internet of Things, swarm intelligence, and neuroscience, while also addressing potential challenges like the inappropriate use of AI techniques, evolving roles of teachers and students, and ethical concerns. This work provides a valuable overview of AI in education, aiding both educators and AI engineers in pursuing further collaborative research [29].

Table III: Production By Author.

No	Researcher	Total Articles*	Scopus H-Index	Affiliation
1	Li J	12	3	Shanghai Sixth People's HospitalThe institution will open in a new tab, Shanghai, China
2	Zhang X	12	9	School of Humanities and natural sciences, Peking Union Medical CollegeThe institution will open in a new tab, Beijing, China
3	Li Y	11	4	Jiangxi University of Science and TechnologyThe institution will open in a new tab, Ganzhou, China
4	Liu X	11	12	West China School of Medicine/West China Hospital of Sichuan UniversityThe institution will open in a new tab, Chengdu, China
5	Wang H	11	5	Wuhan UniversityThe institution will open in a new tab, Wuhan, China
6	Wang Y	11	11	Georgia State UniversityThe institution will open in a new tab, Atlanta, United States
7	Liu J	10	1	Xi'an Shiyou UniversityThe institution will open in a new tab, Xi'an, China
8	Wu J	10	63	Sun Yat-Sen UniversityThe institution will open in a new tab, Guangzhou, China
9	Zhang J	9	1	Affiliated Hospital of Southwest Medical UniversityThe institution will open in a new tab, Luzhou, China
10	Liu Z	8	1	Zhejiang Gongshang UniversityThe institution will open in a new tab, Hangzhou, China

Source: Authors

The implications of these collaborations are numerous. As the community continues to grow and diversify, new lines of research and innovative approaches are expected to

emerge. International and multidisciplinary collaborations, such as those seen in the author network, can lead to significant advances and a better understanding of the challenges and opportunities in the field.

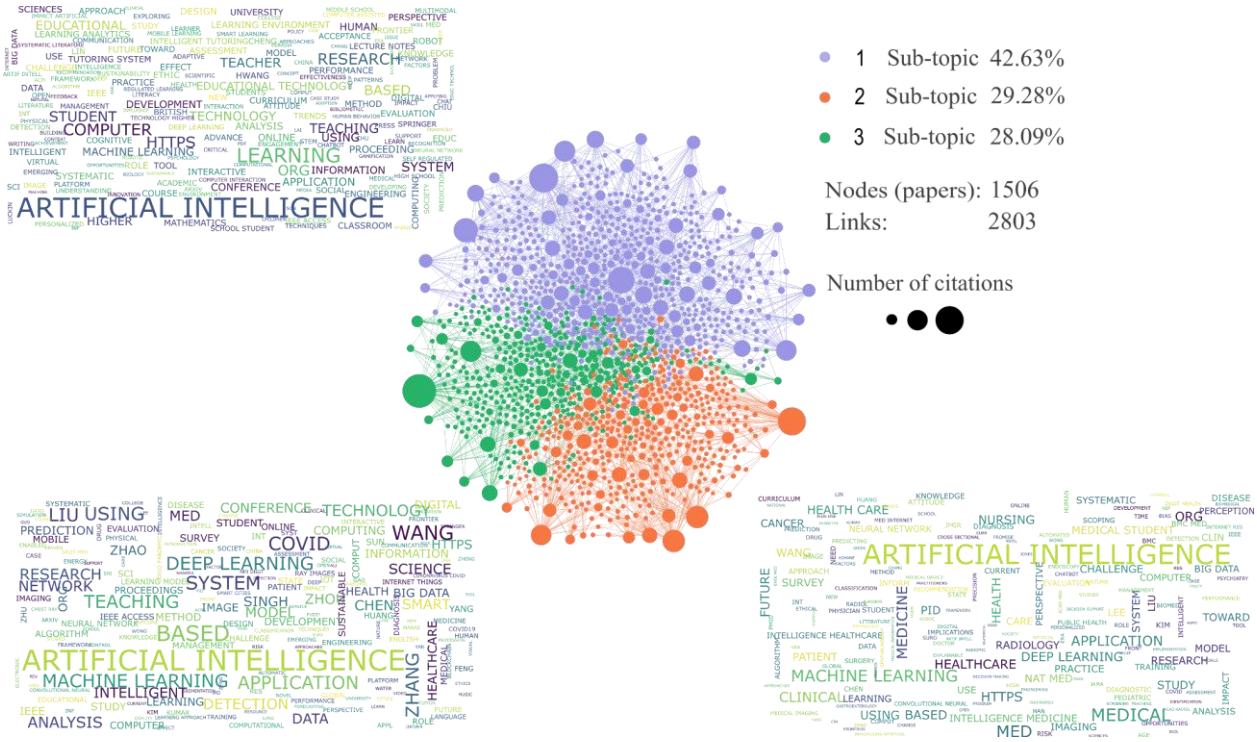

Figure 6. Tree of science
Source: Authors

Root

The root of scientific production highlights classic authors discussing AI in natural sciences, allowing us to understand the Q-learning reinforcement learning algorithm, which stores state values through lookup tables. However, networks facilitate the enhancement of functions, and in this case, LeCun et al. propose improving this algorithm with Multi Q-learning, achieving a performance improvement of 2.5 times [30]. AI continues to enhance means for research to become more productive each day.

For the International Academic Program, AI is part of the global transformation of education, and tools are crucial in advancing the sciences. According to LeCun et al., this involves emerging fields in educational technology [30]. Undoubtedly, pedagogical utilization from teaching aims to achieve two-way interaction: teacher-student-teacher. The impact relationship includes computer science and STEM, emphasizing intelligent systems. Moreover, the subtype of learning produced has been due to big data, which brings computational power and storage. The author highlights its use in medical sciences to

reduce errors, similarly perceived in natural sciences and biology with various highly effective tools. Regarding training, Paranjape et al. discuss data analysis through AI for decision-making and scientific support, stressing the need to integrate digital technology into medical learning [31].

It's striking how many universities, clinics, and institutions implement teaching and learning models to enhance understanding of disciplines and improve information in science programs. In terms of managing information and communication, Jordan et al. propose optimizing computers through experiential learning, highlighting artificial technology's role in human-centered development and feedback [32]. Additionally, Zhou et al. discuss prediction in sciences, particularly in medicine, anticipating four immune system-related diseases through data processing, facilitating preventive medicine systems through algorithms [33].

Amid doubts and concerns over AI usage, its implementation in human care is crucial. Jiang et al. suggest AI mimicking cognitive functions to advance analysis techniques, including detection, diagnosis, treatment, prediction, and prognosis variables [34]. The role of AI in biology is highly relevant, with significant contributions, which we will expand upon in the trunk.

Trunk

Science continues to question the use of AI in the implementation of teaching and learning, in the pursuit of knowledge and practice in each discipline. Papadakis et al. discuss the future of interaction, AI in scientific education [35]. This change in the learning landscape in science education and its social impact raises pedagogical concerns, primarily concerning the conceptual foundation. This unease arises from the potential change in the nature of interaction between students and learning materials, perhaps stemming from a natural fear of the word and action called "change."

Some studies, such as Dwivedi et al., view AI as an emerging field in education [4]. The concern that arises is how to use it in teaching and learning in higher education. It highlights the importance of STEM and its significant value in quantitative methodology for data comprehension. There are numerous studies on AI and the transformation to online educational systems. For Churi et al., this involves a combination of prediction and computation, all aimed at interpreting students' academic performance [36]. Knowledge acquisition forms the basis of these studies, demonstrating improvements in learning outcomes.

There are many concerns about the influence of AI in education. Ouyang et al. consider it the optimal form of teaching in higher education and delve into its effects and implications in research [26]. They emphasize resource recommendations and the ease of evaluation as learning experiences. Meanwhile, other research predicts fire risk in cities through big data.

Yongchang et al. argue that AI should transform cities into smart cities as a cultural aspect of global change, driven by data processing and prevention [37].

In the health sciences, the positive impact of AI is evident in image analysis and natural language processing. According to Tjoa et al., understanding the underlying mechanisms of algorithms is crucial for facilitating human-machine interaction and interpreting studies on complex patterns [20]. There's also an AI methodology for the arts, particularly in interpreting paintings. Chiu et al. discuss a deep learning-based art learning system tailored to classify and identify art, showcasing AI's broad and profound application across different fields and sciences [38].

In conclusion, discussions revolve around enhancing methods in science learning through AI. Longo argues that AI is one of the disciplines revolutionizing education worldwide, aiming to illustrate through qualitative research how it records this impact to enhance teaching and learning [39].

Branches

In modern times, the impact of AI is increasingly significant, with digital tools for learning and teaching taking a prominent place in institutions, especially those focused on sciences and biology. The reason is clear and precise: the ease of information transmission and communication becomes more practical. According to Martin et al. [40], systematic review is comprehensive, synthesizing publications, research topics, methods, and AI applications. What do the sciences seek with the provision of information? The ease of obtaining and practically processing information. Yang et al. [41] emphasize the crucial nature of digital literacy, which everyone should possess. The need for advanced AI is part of a modern world that seeks knowledge and transformation in information management.

Jia and Tu [42] propose a conceptual learning model, achieving self-efficacy, learning motivation, and critical awareness. It aims to awaken students' motivation and provide tools for expedited research. Amid understanding the use of digital technologies, Mertala et al. [43] discuss three misconceptions some communities have about AI: AI is not cognitive concepts inherent to humans; AI cannot be considered as human; it is not pre-installed intelligence. The authors argue that AI is misunderstood as a specific technology.

Research agrees that a balance must be struck between utilizing advanced technologies and adapting to learning changes. Mustopa et al. [44] highlight the challenges AI poses for teacher education students, particularly internet access and supporting infrastructure. However, the absence or lack of human resources is another significant difficulty. How to adapt to AI-driven changes? Ali et al. [45] suggest that systems like Chat GPT systematically enhance student participation and accessibility, addressing critical issues to consider.

Technological tools influence education, as stated by Jia et al. [46], directly linking students to Social Robotics, educational technology research, and development. Refusing to

embrace change signifies true digital illiteracy. In research, positions like those of Forero-Cobra et al. [47] argue that educators' lack of knowledge and skills in Machine Learning and AI limits optimal implementation in education, emphasizing the need for bi-directional learning between teacher and student to enhance skill development.

It's crucial to understand that education isn't at a crossroads but rather part of a changing reality. According to Annuš [48], personalized learning, automated assessment, predictive models, virtual reality in education, and accessible literature reviews are all possible outcomes. Su et al. [49] propose using STEM technologies to explore AI's impact on sustainable development, enhancing academic and scientific training.

Finally, concerns arise about potential epistemological loss in using AI in teaching and learning processes. Cheung et al. [50] stress the use of an epistemic framework to review, evaluate, and critique scientific knowledge with AI. Clearly, human elements and cultural knowledge cannot be separated from AI to provide meaning and context.

Discussion

AI and its use in the sciences and biology have been a technological transformation involving humans through knowledge with a cultural impact. Researchers worldwide agree on the urgency to leap into digital technologies of information and communication. Some cultures, societies, and individuals resist the systematic use of digital tools citing fears, yet they value the speed of information processing.

In this regard, questions arise: Is AI suitable for research models in sciences and biology? Is this a cultural and social change? Does it promote a paradigm shift? Definitely, research requires technological changes to optimize time and enhance investigations. Each day brings new knowledge, and in the current scientific revolution, new questions emerge.

Digital literacy has been a two-way process: learning for the teacher (teaching) and learning for the student. What does this mean? It means researchers must be aware of new technological tools and update their methods of learning and teaching. This optimization of tools provides clarity in development, making leaps in knowledge advantageous for researchers.

Conclusions

When we refer to AI in the sciences and biology, we observe its impact across academia, healthcare, laboratories, teaching, and learning. It has become the way technologies compel us to update knowledge to optimize processes. Education is transforming, and its application in professional life is profound.

Today, we are discussing digital tools shaping a future and societal and cultural change among the population at large. These devices have implemented high-speed protocols to obtain real-time information.

In these times, digital illiteracy is also discussed, covering all social and academic fields, particularly those hesitant to embrace the technology revolution.

Looking at sciences and biology, we witness significant advancements. Focusing on healthcare instrumentation, we can appreciate the measurable benefits of using modern equipment. This underscores the tangible use of AI in healthcare, alongside its statistical analysis capabilities and information management.

Universities and the global education system are increasingly developing tools based on digital platforms, marking a transformative shift in education worldwide. Questions arise about where classes will be conducted, how information will be received globally, and what future classes will look like.

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