Incidences of artificial intelligence in contemporary education

Incidencias de la inteligencia artificial en la educación contemporánea

Dr. José-Ramón Sanabria-Navarro. Associate Professor, Department of Physical Education, Recreation and Sports, University of Cordoba, Monteria (Colombia) (josesanabrian@correo.unicordoba.edu.co) (https://orcid.org/0000-0001-9565-3415)

Dr. Yahilina Silveira-Pérez. Associate Professor, Department of Economics, University of Sucre, Sincelejo (Colombia) (yahilina.silveira@unisucre.edu.co) (https://orcid.org/0000-0002-1536-9287)

Dr. Digna-Dionisia Pérez-Bravo. Associate Professor, Department of Education Sciences, Private Technical University of Loja (Ecuador) (ddperez@utpl.edu.ec) (https://orcid.org/0000-0003-2746-3868)

Dr. Manuel de-Jesús-Cortina-Núñez. Professor, Department of Physical Education, Recreation and Sports, University of Cordoba, Monteria (Colombia) (mjcortinanunez@correo.unicordoba.edu.co) (https://orcid.org/0000-0001-7558-351X)

ABSTRACT
The term "Artificial Intelligence" was coined in 1956 at a conference at Dartmouth College and since then it has undergone constant development and has evolved radically. Prominent pioneers of the term include John McCarthy, Marvin Minsky, Allen Newell, and Herbert A. Simon. The application of AI in education worldwide has increased dramatically with its importance growing at an increasing rate. The objective of this research is to bibliometrically analyze applications of AI in contemporary education. The methodology includes a Prisma of the articles of three fundamental databases: Scopus (n=390), Mendeley (n=113), and Science Direct (n=3,594). A total of n=4,097 articles in English and Spanish were analyzed. The systematic literature review of recent works employed a mixed approach using quantitative and qualitative methods. It was inferred by the authors that AI is revolutionizing education by offering personalized and efficient solutions to improve students' learning. One of the main conclusions of this research is that in contemporary education, students are one of the groups that are most affected by AI. Furthermore, the human intelligence of teachers plays a fundamental role since they adapt their methodologies to leverage new technologies. Finally, it is worth noting that decisions made in schools and universities support new educational models based on technology.

RESUMEN
El término «Inteligencia Artificial» fue acuñado en 1956 en una conferencia en Dartmouth College, y desde entonces, este ha experimentado un desarrollo constante y ha evolucionado de manera significativa. Algunos de los pioneros más destacados incluyen a John McCarthy, Marvin Minsky, Allen Newell y Herbert A. Simon. La aplicación de la inteligencia artificial en la educación ha aumentado considerablemente a nivel mundial en la dinámica era digital. El objetivo de la investigación es analizar bibliométricamente las incidencias de la IA en la educación contemporánea. La metodología contiene un Prisma de tres bases de datos fundamentales Scopus (n=390), Mendeley (n=113) y Science Direct (n=3.594), para un total de n=4.097 artículos en idioma inglés y español. La revisión sistematizada de la literatura reciente tiene un enfoque mixto, cuantitativos y cualitativos empleando varios paradigmas de la investigación en función del objetivo, se obtiene que la IA ha revolucionado la educación, ofreciendo soluciones personalizadas y eficientes para mejorar el aprendizaje de los estudiantes. En las principales conclusiones se plantea que en los términos teóricos de mayor impacto están los estudiantes como elemento principal de la IA de la educación contemporánea. Por otra parte, los profesores juegan un papel fundamental en este proceso a través de sus metodologías y el uso de estas tecnologías. Así mismo están los currículos educacionales mediante la toma de decisiones en los colegios y universidades que están apostando por nuevos modelos tecnológicos educativos.

1. Introduction and state of the art

Artificial intelligence (AI) has a profound impact on everyday life. AI is used in different high-stake applications, for example, healthcare, business, government, education, and justice, leading toward a more algorithmic society (Kaur et al., 2022). The influence of algorithms is increasing through its growing presence in most domains, without being noticed and sometimes usurping the identity of other social actors (Garcia-Orosa et al., 2023). The use of AI systems in educational contexts is showing potential opportunities for its use by teachers and students (Flores-Vivar & García-Peñalvo, 2023), enhancing new didactic models.

The use of digital games in learning and early identification of dropout risk in higher education by incorporating AI are critical research topics (Bañeres et al., 2023). In addition, the adoption of AI in educational applications can enhance students' learning competencies and is significant in knowledge-sharing processes across different sectors (Alhumaid et al., 2023) and for epistemic network analysis (Wang et al., 2023). To improve student engagement and motivation, scholars suggested using an AI-based educational data mining approach that enables early recognition and development of personalized recommendations in the flipped classroom (Sayed et al., 2023; Huang et al., 2023).

1.1. Artificial intelligence in education

AI performance prediction modeling is widely used to identify at-risk students and consequently establish student-centered learning pathways, and optimize instructional design and development (Ouyang et al., 2023). Alternatively, it is necessary to reflect on AI, chatbots, and plagiarism in higher education (King & chatGPT, 2023). The above tools, if misapplied, will not develop knowledge, professional competencies, or critical thinking skills, which are vital in diverse professions.

The personalized intelligent manufacturing paradigm with cognitive automation capabilities (Li et al., 2023) has attracted increasing attention by offering an adaptable and flexible solution. The paradigm leverages the advantages of both deep neural networks and reinforcement learning by adopting the power of representation learning, to make accurate and fast decisions when faced with dynamic and complex situations.

This intelligence system develops foresight science with a systematic approach to generate future predictions in planning and management using analytical and predictive tools to understand the past and present (Ednie et al., 2023), while providing information on the future of education. The adoption of appropriate practices using AI-enabled techniques facilitates teaching and learning performance in higher education (Hua-Hu, 2023).

The analysis of learning tactics and strategies in an online environment (Lahza et al., 2023) is a form of pedagogical support for collaborating with students in the development of academic-related content. Analysis of learning tactics is emerging as a viable approach to engage students in higher-order learning. In all the above instances, ethical considerations of AI must be considered (Sun & Ye, 2023). One of the ultimate challenges in philosophy is therefore, determining what deserves moral regard.

Digital explosion and entrepreneurship education is having an impact on promoting entrepreneurial intent for business students (Dabbous & Boustani, 2023) and thus, empowering AI as a form of entrepreneurship. Adoption of AI-based teaching robots (T-bots) for learning using the technology adoption model and context-specific variables (Hussain, 2023) aligns with education efforts in fostering intelligent decisions.

It has become essential for today's learners to gain basic literacy and AI competencies, yet educators do not care about these era-defining trends in contemporary pedagogy (Chai et al., 2023). According to Zhen et al. (2023), virtual technology is widely employed in various sectors such as personal assistance, intelligent customer service, online in various educational modalities and for assessing physical activity in high school children (Ahmed et al., 2023), data visualization, augmented reality, and virtual reality (Cerqueira et al., 2023).

An informed perspective of learning through AI raises concerns on how to train users in handling changes brought about by the introduction of the technology (Arbelaez-Ossa et al., 2023; Ursani & Ursani, 2023). The future of standardized assessment, validity, and confidence in assessment and

scoring algorithms (Aloisi, 2023), therefore considers challenges of using AI to aid standardized high-risk assessment.

1.2. Artificial intelligence software applied in education

Among the AI tools applied in online education are special types of software. English teaching and learning in this information age should be carried out with the help of intelligent system software to counter the disadvantages of the traditional system of teaching and learning (Dong, 2022). According to the current circumstances of teaching in addition to learning, semantic Web technology and AI technology are combined to build an advanced system of teaching and learning.

In the context of AI, scientific research practice has been simplified in terms of technological form and content, that limits students' ability to comprehensively apply technology. The above-mentioned scenario, therefore, becomes an obstacle in the development of superior technological features in the context of AI (Hu et al., 2023). Online and adaptive learning has already advanced within academia. However, the most significant changes are yet to come. These evolving technologies have the potential to change traditional roles in colleges and universities to the point where many educators will reconsider their roles as teachers, researchers, and administrators (Picciano, 2019).

The future of higher education and education through online technology, specifically adaptive learning and analytics infused by AI software, is increasingly developing as part of teaching methodology. Transformation of educational concepts, reform of teaching courses, and reorganization of teaching materials are critical ways to strengthen the quality of contemporary education through AI (Zhou, 2023). This is related to the development of teaching materials suitable for various regions and schools to deepen students' understanding and enhance their interest in courses.

It also serves to make decisions in application domains such as justice, health care, and education (Hort et al., 2023) and as deep learning systems trained to read, classify, and respond to human emotions (Ho et al., 2023). Computer-assisted instruction also has some degree of lock-in. The use of AI causes students to learn passively, without goals, education, and guidance (Shen & Tan, 2023). Based on the above scenarios, there are models for evaluating the effectiveness of AI-based computer-assisted physical education teaching and training, which help to focus goals and determine guidance.

Real object understanding using 3D haptic virtual reality for online education is another tool (Allaoua-Chelloug et al., 2023). This computer vision technology incorporates tasks that implement basic filtering for image classification. The main areas of research in this field include object detection and recognition, and interesting aspects of education at different levels.

Detailed exploration of AI and digital education provides a sustainable impact on youth and society (Tongkachok et al., 2023). Therefore, using AI launches some digital applications for digital education, an element that increased during the COVID-19 pandemic. For all the above instances, it is necessary to define the research question: What are the incidences of AI in contemporary education through a bibliometric analysis? Establishing as a general objective: To analyze bibliometrically the incidences of AI in contemporary education.

2. Material and methods

In this work, a descriptive and retrospective bibliometric analysis was conducted on the impact of AI in online education, using, as a guide, an adaptation of the proposal of Matthew et al. (2021). The PRISMA methodology was applied, thus endorsing the systematic review.

This review has a mixed approach as a contribution to the application of several types of research paradigms adapted from the post-positivist paradigm since it is evident that AI is a phenomenon that exists but is not yet fully explored. The qualitative and quantitative approach is combined with critical theory. The constructivist paradigm is also mixed since the articles taken as references are based on research that was built on socially proven realities, according to different contexts and times, where the countries, as well as their situations and analysis, are different.
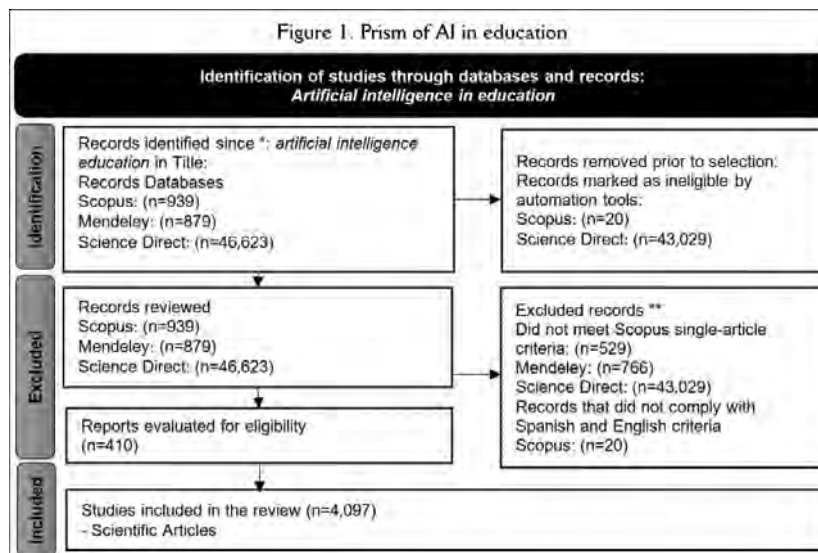
2.1. Instrument for data collection

For the research, conceptual categories are established considering the incidence of AI in education, from which the dimensions (D) and indicators (I) that lead the research are defined and are based on the analysis of the previously established information:

- D.1: Authors. I: Total citations, citations per year, publication timeliness, affiliation, country, H index.
- D.2: Journals. I: Main publications, journal quartiles, indexation, impact factor, and countries.
- D.3: Contributions I: Subject matter, methodologies used, analysis techniques, and samples used.

2.2. Population and sample

The steps carried out for the visual design of the PRISMA diagram (Figure 1) are described below.

Figure 1. Prism of AI in education

Identification of studies through databases and records:
Artificial intelligence in education

Identification

Records identified since *: *artificial intelligence education* in Title:
Records Databases
Scopus: (n=939)
Mendeley: (n=879)
Science Direct: (n=46,623)

Records removed prior to selection:
Records marked as ineligible by automation tools:
Scopus: (n=20)
Science Direct: (n=43,029)

Excluded

Records reviewed
Scopus: (n=939)
Mendeley: (n=879)
Science Direct: (n=46,623)

Excluded records **
Did not meet Scopus single-article criteria: (n=529)
Mendeley: (n=766)
Science Direct: (n=43,029)
Records that did not comply with Spanish and English criteria
Scopus: (n=20)

Reports evaluated for eligibility (n=410)

Included

Studies included in the review (n=4,097)
- Scientific Articles

Note. Adapted from Matthew et al. (2021).

1) Identification of the key steps of the systematic review: the systematic review generally includes sub-steps such as:

- Search for studies: The following search equation was used: title ("artificial and intelligence and + and education") and limit-to (language, "English") or limit-to (language, "Spanish"). As can be seen in the equation, English and Spanish were the inclusion criteria.
- Selection of studies: To obtain the best results in the exploration carried out, search strategies were applied to all the literature indexed in Scopus, Mendeley, and Science Direct related to this topic up to 2023.
- Data extraction: The tools of the bibliometric package of the R statistical program (Aria & Cuccurullo, 2017) were used to extract the information of the variables to be analyzed according to the dimensions explained above.
- Evaluation of the quality of the evidence: After the previous steps, the results were analyzed descriptively, and based on this information, the tables and graphs presented in the results section were prepared.

3. Analysis and results

As established in the methodology, the study starts by identifying incidences represented by the conceptual categories related to the object of study, extracted from the keywords of the research included in the sample. The students are the main element of the AI, since their performance with AI varies depending on their human condition. On the other hand, teachers play a fundamental role in this process through their methodologies and the use of these technologies, where the basis of everything is in the technological

education of all the actors in the educational system. Alternatively, AI is a contemporary experiment that is directly influencing educational curricula, and the decision making of students and teachers, where schools and universities are putting their faith in new technological models.

All subjects of the curriculum, including physical education, are being empowered by these AI spaces in education, which makes this topic systemic. Systemic factors include a trainer of information networks, a generator of large databases, a developer of deep learning, electronic learning, new professional skills, a generator of new methodologies such as virtual learning environments and virtual learning objects. In summary, the most relevant incidences in terms of conceptual categories found are (Figure 2): Students, Technology-based learning (e learning), Teaching methods and systems, Prognostic-based learning, Virtual teaching, Computer-assisted instruction, Quality control, Information management, Complex learning, and Curriculum.

Figure 2. Analysis of conceptual categories (occurrences)

Note. Bibliometrix. Based on Scopus 2023 database.

3.1. D.1: Authors

One of the indicators of AI in education is the authors who publish most on the subject, as they depict a direct relationship with contemporary topics on the subject. The authors' dimension highlights the people who research and write about the subject under research. Their objective is to share their findings and discoveries with the scientific community and the public and to contribute to the advancement of knowledge in their field of study. With this statement in mind, we will analyze some indicators of AI in contemporary education that directly impact the authors (Table 1). The table shows the main authors publishing in journals focused on AI topics globally. Only 10 authors were selected using Bibliometrix. Also present are the total number of citations per year, the most current AI-related articles in education, the H index that provides the citation level, affiliation, and countries. In order to achieve the greatest possible effectiveness, these variables were reviewed individually by each author in their own scientific network platforms such as Google Scholar, Scopus index, among others,

However, the analysis here shows that developed countries are still at the forefront of technologies and therefore of AI in education. Likewise, the authors are in the best universities in their countries that provide them with a high possibility of research and time to carry it out. It is an extraordinarily topical subject considering the years in question. Citation rates are high, which shows the interest in the subject, and this has allowed the growth of the researchers mentioned in Table 1.

North America, Europe, and Oceania lead, followed by the Asian continent. The total absence of South America and Africa continues to demonstrate that the generation of AI for education is a matter of investment, resources, and budgetary availability. It is noteworthy that these authors established their publications until the year 2020 and although they are still among the first, there is no evidence of

publications between 2021 and 2023. In general, there are 10 authors; eight of them belong to developed countries and two to underdeveloped countries. The number of publications within the last five years is seven and three within the last 10 years. Likewise, the mean overall average citation index is 113, the mean citation index per year is 20 and the mean H-index is 19. The leading country in AI in contemporary education according to its authors is Australia (2), considering the top 10 authors.

Table 1. Authors' dimension						
Names and surnames	Citations	Citations by year	Present	Index H	Affiliation	Country
Popenici. S	240	34	2017	3	Charles Darwin University	Australia
Roll. I	200	25	2016	23	Technion - Israel Institute of Technology	Israel
Chen. L	138	35	2020	1	Yango University, Fuzhou	China
Timms. M.J.	136	17	2016	12	Australian Council for Educational Research	Australia
Wartman. S.A.	86	14	2018	20	Academic Health Centers	United States of America
Chatterjee. S.	70	18	2020	29	Indian Institute of Technology Kharagpur	India
Winkler-Schwartz. A.	70	14	2019	15	Institut-Hôpital Neurologique de Montréal	Canada
Guan. C.	68	17	2020	57	Nanyang Technological University	Singapore
Hinojo-Lucena. F.	68	14	2019	16	Universidad de Granada	Spain
Knox. J.	56	14	2020	13	Centre for Research in Digital Education, The University of Edinburgh	United Kingdom

Note. Developed by the authors. Based on Bibliometrix results from Scopus, Mendeley, and Science Direct 2023 databases.

3.2. D.2: Journals

A scientific journal is a periodical that contains original, peer-reviewed articles in a specific field of science. Scientific journals are a means of disseminating recent research and discoveries to a community of researchers and specialists in a subject and are an important part of the review and validation process in science. For all the above reasons, it is necessary to establish the essential elements of the main journals that publish topics related to AI in contemporary education as a dimension of research (Table 2).

Table 2. Dimension of scientific journals				
Scientific journals	Quartiles of the journals	Journal Indexing	Journal impact factor	Country
Research and Practice in Technology-Enhanced Learning	Q-1	JCR, SJR	18	Singapore
International Journal of Artificial Intelligence in Education	Q-1	JCR, SJR	53	USA
IEEE Access	Q-1	JCR, SJR	158	USA
International Journal of Artificial Intelligence in Education	Q-1	JCR, SJR	53	USA
Academic Medicine	Q-1	JCR, SJR	162	USA
Education and Information Technologies	Q-1	JCR, SJR	48	USA
Journal of Surgical Education	Q-1	JCR, SJR	59	USA
International Journal of Innovation Studies	Q-2	SJR	12	China
Education Sciences	Q-2	JCR, SJR	30	Switzerland
Learning, Media, and Technology	Q-1	JCR, SJR	49	UK

Note. Developed by the authors. Based on Scopus, Mendeley, and Science Direct 2023 databases.

Considering Table 2, it can be stated that within the 10 scientific journals that publish the most on the topic of AI in education, 80% are in the first quartile of publication (Q-1) and 20% in the second quartile (Q-2). Ninety percent belong to the Journal Citation Reports (JCR) and 10% to the Scimago Journal & Country Rank (SJR). The above defines a position that all publications related to the research are high impact and evaluated by double-blind peer review systems, Open Access, and are collected in world-class journals compiled by the Scopus database. The average impact factor of the journals is 64.2.

Countries publishing related reputable journals include the United States of America that is in first place with six journals, while Singapore, China, Switzerland, and the United Kingdom all have one journal. All the publications that promote the topic of AI in contemporary education are from developed countries centered on three continents: North America, Europe, and Asia. South America and Africa are absent in journals of this type. This last indicator coincides with the same indicator of the authors' countries, which solidifies that AI in education is a topic that is promoted by developed countries.

3.3. D.3: Contributions

Scientific contributions are original and significant contributions that scientists make in their areas of research to expand knowledge and solve problems. These contributions may include discoveries, theories, methods, innovative techniques, experiments, and studies that confirm or refute hypotheses. The scientific contributions of AI in contemporary education are critical for the progress of science and the improvement of the quality of life, so we analyze in this research (Table 3) the main impacts of these methodologies and techniques.

Table 3. Scientific contributions			
Subject	**Methodology**	**Analysis techniques**	**Sample**
Impact of AI on teaching and learning in higher education.	Systematic review	Bibliometrics	Not applicable (N/A)
Evolution and revolution of AI in education.	Systematic review	Modeling approach, literature review, system description, system evaluation, or learning theories.	47 items
Dynamic modeling of spatial and satellite coalition robots.	LAGRANGE function, Newton-Euler function	Integral effort learning control scheme based on the Barrier-Lyapunov function.	N/A
Educational cobots and intelligent classrooms.	Sociocriticism	Problem formulation	N/A
AI in medical education.	Systematic curricular attention	Statistical domain expertise, machine learning, and robotics	N/A
AI in secondary and higher education.	Quantitative analysis	Structural equations	329 subjects
AI in medical education.	Benchmarking	Virtual reality simulation. Machine learning to evaluate the surgical experience	12 items
AI and innovation in education.	Systematic review	Bibliometrics	400 items
AI in higher education.	Systematic review	Bibliometrics	132 items
AI in Chinese education.	Quantitative analysis	Documentary review	3 companies

Note. Prepared by the authors. Based on the Scopus, Mendeley, and Science Direct 2023 databases.

All contributions revolve around AI in online education. However, similarities and differences among them are enhanced. For example, employing AI in teaching and learning, in the evolution and revolution of education, and the insertion of robots in different educational areas through dynamic modeling. Contemporary trends are developing such as educational robots (T-bots) and intelligent classrooms, and the inclusion of AI in medical education, at educational levels, as an innovative element of different environments, settings, and learning objectives.

AI in education is a new cycle of technological innovation that, with the development of science and technology, is here to stay. AI is of vital importance in understanding, management, and teacher training for the teaching of new generations for the immediate future that is not long in coming.

Figure 3. Historical evolution of AI in education
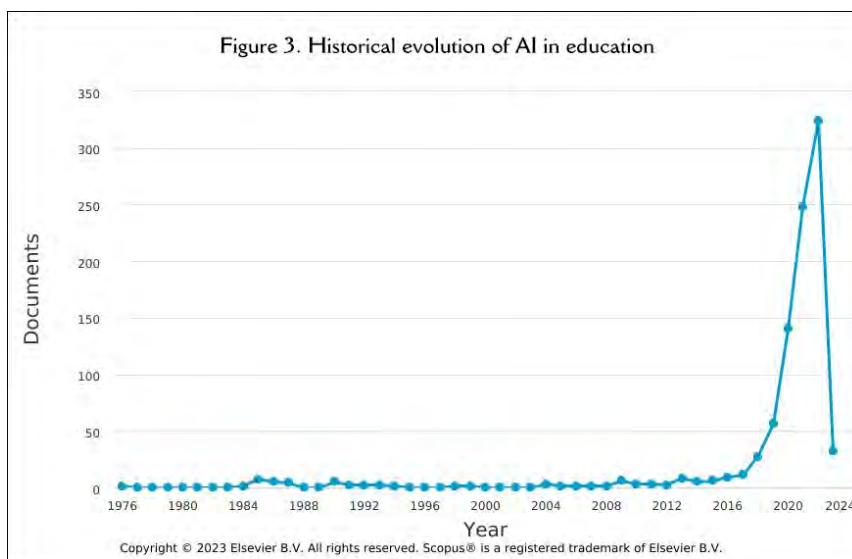
Note. Scopus 2023 database.

Within the methodologies shown in these articles on AI in contemporary education, it is evident that 80% are theoretical reviews and 20% are quantitative analyses. Systematic reviews, socio-critical elements, curricular attention, benchmarking and LAGRANGE function, and Newton-Euler function are derived from the above.

Among the techniques that can be identified are the following: Bibliometrics 30% of publications, documentary review 10%, modeling approach, literature review, system description, system evaluation or learning theories 10%, integral effort learning control scheme based on the Barrier-Lyapunov function 10%, problem formulation 10%, statistical expertise domain, machine learning, and robotics 10%, structural equations, virtual reality simulation and machine learning to evaluate surgical experience 10%.

Concerning the selected samples, it can be said that 40% defined it as only empowering reflection articles, another 40% used a sample of articles, 10% worked on a review of documents in companies, and only 10% did it with subjects. This shows an incipient lack of concrete practice in the different social realities. Once the previous results have been determined, it is necessary to define the evolution of AI in education to arrive at the present. For this purpose, the trajectory of scientific articles in the Scopus database was consulted (Figure 3).

AI in education has experienced constant advance since its conception in 1956, establishing its first theoretical antecedents in 1976. Some important milestones refer to the fact that it was in 1956 when the term AI was first discussed at a conference at Dartmouth. In the 1960s-70s, the first AI systems were developed, including pattern recognition and natural language understanding. In the 1980s-90s, advances in information processing and data storage were developed that enabled AI systems to improve on tasks such as machine learning and planning. In the 2000s-2010s, significant advances in deep learning and massive data analysis occurred, allowing AI to improve in tasks such as image recognition and text generation.

From 2015 to the present, AI has continued to evolve at a rapid pace, with advances in technologies such as reinforcement learning, natural language processing, and robotics. AI has also been integrated into a wide variety of practical applications, including facial recognition, virtual assistant, and enterprise data analytics. AI is beginning to be used to personalize education, adjusting the pace and content according to the needs of individual students.

In 2017, AI tools were developed that allowed teachers to evaluate and improve their teaching, as well as allowing students to get real-time feedback on their performance. In 2019, virtual reality and augmented reality began to be used to enhance the learning experience, allowing students to interact with content in a more immersive way.

The COVID-19 pandemic empowered distance education and AI-developing solutions to support online learning becoming a necessity. In 2021, AI was increasingly used to create chatbots and virtual assistants to help students resolve queries and enhance their learning experience and its elements that are still being developed to this day.

4. Discussion and conclusions

The results provide evidence that AI research may be on the rise, agreeing with Hinojo-Lucena et al. (2019). After 2000, recognition is made on the era of cognitive intelligence, mimicking human intelligence and cognitive abilities as planned by Garcia-Orosa et al. (2023). In the last decade, from 2010, the term general intelligence is discussed, with the creation of general AI systems, which can perform a wide range of tasks, including learning new knowledge and skills.

However, discriminatory characteristics are not evident given that AI does not inherently establish gender or race patterns. All this relates to possible algorithmic biases that could negatively affect certain social groups if any historical discriminatory elements are included in the algorithms. Technologies most in demand are those based on AI, such as intelligent tutoring systems, adaptive learning management systems, and video games (Vila & Penín, 2007).

AI is impacting human relationships, through communication, relationships, and ways of interacting with the surrounding world. On the one hand, it improves communication and collaboration through online platforms and instant messaging applications. On the other hand, self-service for example employs

machines with a more natural and fluid interaction. However, there are also challenges such as the increasing dependence on technology and its negative impact on people's social skills and ability to communicate. In addition, there are concerns about the privacy and security of personal information, as well as the possibility of excessive automation of human jobs. While humans sometimes find it difficult to be impartial, an ethical challenge of AI systems (Flores-Vivar & García-Peñalvo, 2023) is to make them fair and impartial rather than to perpetuate discrimination or injustice.

In partial fulfillment of the research objective, it was concluded that AI has revolutionized education, offering personalized and efficient solutions to improve student learning. There are also concerns about its long-term impact and its potential to replace teachers. One of the main conclusions obtained is that AI focuses on developing algorithms and techniques that allow machines to perform tasks that normally require human intelligence. Among the various functions it performs are decision-making, learning, and problem solving.

The way of working has changed, for instance in medicine where medical diagnostic systems help healthcare professionals diagnose illnesses, personalize treatments, and improve efficiency in providing health care. Robots are also being developed to perform specific tasks, such as cleaning houses and patient care in hospitals. AI is used in voice and face recognition applications, such as Apple's Face ID and Google's camera assistant, to verify the identity of users. It is applied to automate repetitive jobs, such as inventory management and data classification.

Another important conclusion is the possible resistance of several scientific and academic communities in the indiscriminate application of AI, given that it could be transforming human relationships when not used responsibly. One of the most obvious applications, which requires efficiency and responsibility, is the automation of processes, generating higher levels of productivity, as well as the analysis of substantial amounts of data and the discovery of patterns and trends. In addition, it is being used to develop new products and services, as well as to improve customer experience.

Industrial security does not escape the influence of AI, for example, through the development of surveillance and threat detection systems. However, it is essential to analyze the ethical and social challenges involved. As technology advances, AI is expected to have an increasing impact on human life. The world is transforming, and dissimilar opportunities are offered to improve people's lives. As future lines of research, a more in-depth study of the contributions of AI research in education will be conducted to determine its impact on student learning. An analysis of the use of virtual assistants in learning will also be applied.

Authors' Contribution

Funding Agency

References

Ahmed, A., Aziz, S., Qidwai, U., Farooq, F., Shan, J., Subramanian, M., Chouchane, L., Einatour, R., Abd-Alrazaq, A., Pandas, S., & Sheikh, J. (2022). Wearable artificial intelligence for assessing physical activity in high school children. *Sustainability*, *15*(1). https://doi.org/10.3390/su15010638

Alhumaid, K., Naqbi, S.A., Elsori, D., & Mansoori, M.A. (2023). The adoption of artificial intelligence applications in education. *International Journal of Data and Network Science*, *7*(1), 457-466. https://doi.org/10.5267/j.ijdns.2022.8.013

Allaoua-Chelloug, S., Ashfaq, H., Alsuhibany, S., Shorfuzzaman, M., Alsufyani, A., Jalal, A., & Park, J. (2023). Real objects understanding using 3D haptic virtual reality for e-learning education. *Computers, Materials & Continua*, *74*(1), 1607-1624. https://doi.org/10.32604/cmc.2023.032245

Aloisi, C. (2023). The future of standardised assessment: Validity and trust in algorithms for assessment and scoring. *European Journal of Education*, *58*(1), 98-110. https://doi.org/10.1111/ejed.12542

Arbelaez-Ossa, L., Rost, M., Lorenzini, G., Shaw, D.M., & Elger, B.S. (2023). A smarter perspective: Learning with and from AI-cases. *Artificial Intelligence in Medicine*, *135*. https://doi.org/10.1016/j.artmed.2022.102458

Aria, M., & Cuccurullo, C. (2017). Bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, *11*(4), 959-975. https://doi.org/10.1016/j.joi.2017.08.007

Bañeres, D., Rodríguez-González, M.E., Guerrero-Roldán, A.E., & Cortadas, P. (2023). An early warning system to identify and intervene online dropout learners. *International Journal of Educational Technology in Higher Education*, *20*(1), 1-25. https://doi.org/10.1186/s41239-022-00371-5

Cerqueira, J.M., Cleto, B., Moura, J.M., Sylla, C., & Ferreira, L. (2023). Potentiating learning through augmented reality and serious games. In *Springer Handbook of Augmented Reality* (pp. 369-390). Springer. https://doi.org/10.1007/978-3-030-67822-7_15

Chai, C.S., Chiu, T.K.F., Wang, X., Jiang, F., & Lin, X.F. (2023). Modeling Chinese Secondary School students' behavioral intentions to learn artificial intelligence with the theory of planned behavior and self-determination theory. *Sustainability*, *15*(1), 605-605. https://doi.org/10.3390/su15010605

Dabbous, A., & Boustani, N.M. (2023). Digital explosion and entrepreneurship education: Impact on promoting entrepreneurial intention for business students. *Journal of Risk and Financial Management*, *16*(1), 27-48. https://doi.org/10.3390/jrfm16010027

Dong, Y. (2022). Application of artificial intelligence software based on semantic web technology in english learning and teaching. *Journal of Internet Technology*, *23*(1), 143-152. https://doi.org/10.53106/160792642022012301015

Ednie, G., Kapoor, T., Koppel, O., Piczak, M.L., Reid, J.L., Murdoch, A.D., Cook, C.N., Sutherland, W.J., & Cooke, S.J. (2022). Foresight science in conservation: Tools, barriers, and mainstreaming opportunities. *Ambio*, *52*(2), 411-424. https://doi.org/10.1007/s13280-022-01786-0

Flores-Vivar, J., & García-Peñalvo, F. (2023). Reflexiones sobre la ética, potencialidades y desafíos de la inteligencia artificial en el marco de una educación de calidad (ODS4). [Reflexiones sobre la ética, potencialidades y desafíos de la IA en el marco de la Educación de Calidad (ODS4)]. *Comunicar*, *74*, 37-47. https://doi.org/10.3916/C74-2023-03

García-Orosa, B., Canavilhas, J., & Vázquez-Herrero, J. (2023). Algorithms and communication: A systematized literature review. [Algoritmos y comunicación: Revisión sistematizada de la literatura]. *Comunicar*, *74*, 9-21. https://doi.org/10.3916/C74-2023-01

Hinojo-Lucena, F., Aznar-Díaz, I., Cáceres-Reche, M., & Romero-Rodríguez, J. (2019). Artificial intelligence in higher education: A bibliometric study on its impact in the scientific literature. *Education Sciences*, *9*(1), 51-60. https://doi.org/10.3390/educsci9010051

Ho, M., Le, N., Mantello, P., Ho, M., & Ghotbi, N. (2023). Understanding the acceptance of emotional artificial intelligence in japanese healthcare system: A cross-sectional survey of clinic visitors' attitude. *Technology in Society*, *72*, 102-166. https://doi.org/10.1016/j.techsoc.2022.102166

Hort, M., Moussa, R., & Sarro, F. (2023). Multi-objective search for gender-fair and semantically correct word embeddings. *Applied Soft Computing*, *133*, 109916-109916. https://doi.org/10.1016/j.asoc.2022.109916

Hu, Y., Fu, J.S., & Yeh, H. (2023). Developing an early-warning system through robotic process automation: Are intelligent tutoring robots as effective as human teachers? *Interactive Learning Environments*, (pp. 1-14). https://doi.org/10.1080/10494820.2022.2160467

Hua-Hu, K. (2023). An exploration of the key determinants for the application of AI-enabled higher education based on a hybrid soft-computing technique and a DEMATEL approach. *Expert Systems with Applications*, *212*, 118-762. https://doi.org/10.1016/j.eswa.2022.118762

Huang, A.Y.Q., Lu, O.H.T., & Yang, S.J.H. (2023). Effects of artificial Intelligence-enabled personalized recommendations on learners' learning engagement, motivation, and outcomes in a flipped classroom. *Computers and Education*, *194*. https://doi.org/10.1016/j.compedu.2022.104684

Hussain, A. (2023). Use of artificial intelligence in the library services: prospects and challenges. *Library Hi Tech News*, *40*(2), 15-17. https://doi.org/10.1108/LHTN-11-2022-0125

Kaur, D., Uslu, S., Rittichier, K.J., & Durresi, A. (2022). Trustworthy artificial intelligence: A review. *ACM Computing Surveys*, *55*(2), 1-38. https://doi.org/10.1145/3491209

King, M.R. (2023). A conversation on artificial intelligence, chatbots, and plagiarism in higher education. *Cellular and Molecular Bioengineering*, *16*(1), 1-2. https://doi.org/10.1007/s12195-022-00754-8

Lahza, H., Khosravi, H., & Demartini, G. (2023). Analytics of learning tactics and strategies in an online learnersourcing environment. *Journal of Computer Assisted Learning*, *39*(1), 94-112. https://doi.org/10.1111/jcal.12729

Li, C., Zheng, P., Yin, Y., Wang, B., & Wang, L. (2023). Deep reinforcement learning in smart manufacturing: A review and prospects. *CIRP Journal of Manufacturing Science and Technology*, *40*, 75-101. https://doi.org/10.1016/j.cirpj.2022.11.003

Matthew, J., Pagea, J.E., Mckenziea, P.M., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., Shamseer, L., Tetzlaff, J.M., Akl, E.A., Brennan, S.E., Chou, R., Glanville, J., Grimshaw, J.M., Hróbjartsson, A., Lalu, M.M., Li, T., Loder, E.W., Mayo-Wilson, E., ... Moher, D. (2021). Declaración PRISMA 2020: Una guía actualizada para la publicación de revisiones sistemáticas. *Revista Española de Cardiología*, *74*(9), 790-799. https://doi.org/10.1016/j.recesp.2021.06.016

Ouyang, F., Wu, M., Zheng, L., Zhang, L., & Jiao, P. (2023). Integration of artificial intelligence performance prediction and learning analytics to improve student learning in online engineering course. *International Journal of Educational Technology in Higher Education*, *20*(1). https://doi.org/10.1186/s41239-022-00372-4

Picciano, A.G. (2019). Artificial intelligence and the academy's loss of purpose. *Online Learning Journal*, *23*(3), 270-284. https://doi.org/10.24059/olj.v23i3.2023

Sayed, B.T., Madanan, M., & Biju, N. (2023). An efficient artificial intelligence-based educational data mining approach for higher education and early recognition system. *SN Computer Science*, *4*(2), 130-130. https://doi.org/10.1007/s42979-022-01562-7

Shen, C., & Tan, Y. (2023). Effect evaluation model of computer aided physical education teaching and training based on artificial intelligence. *Computer-Aided Design and Applications*, *20*(S5), 106-115. https://doi.org/10.14733/cadaps.2023.S5.106-115

Sun, F., & Ye, R. (2023). Moral considerations of artificial intelligence. *Science and Education*, *32*(1), 1-17. https://doi.org/10.1007/s11191-021-00282-3

Tongkachok, K., Ali, B.M., Ganguly, M., Kumar, S., Malathi, M., & Subramanian, M. (2023). A detailed exploration of artificial intelligence and digital education and its sustainable impact on the youth of society. In *Proceedings of Second International Conference in Mechanical and Energy Technology* (pp. 139-146). Springer. https://doi.org/10.1007/978-981-19-0108-9_15

Ursani, Z., & Ursani, A.A. (2023). The theory of probabilistic hierarchical learning for classification. *Annals of Emerging Technologies in Computing*, *7*(1), 61-74. https://doi.org/10.33166/AETiC.2023.01.005

Vila, E.M.S., & Penín, M.L. (2007). Introduction to special issue AI techniches applied in education. *Inteligencia Artificial*, *11*(33), 7-12. https://doi.org/10.4114/ia.v11i33.914

Wang, X., Liu, Q., Pang, H., Tan, S.C., Lei, J., Wallace, M.P., & Li, L. (2023). What matters in AI-supported learning: A study of human-AI interactions in language learning using cluster analysis and epistemic network analysis. *Computers and Education*, *194*. https://doi.org/10.1016/j.compedu.2022.104703

Zhen, R., Song, W., He, Q., Cao, J., Shi, L., & Luo, J. (2023). Human-computer interaction system: A survey of talking-head generation. *Electronics*, *12*(1), 218-239. https://doi.org/10.3390/electronics12010218

Zhou, W. (2023). The development system of local music teaching materials based on deep learning. *Optik*, *273*, 170421-170421. https://doi.org/10.1016/j.ijleo.2022.170421