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A Scientific Review of Generative Artificial Intelligence Models in Higher Education

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***Abstract*—**The development of generative artificial intelligence models in students' autonomous learning has generated special interest in scientific research. This study proposes a literature review from a multivariate analysis to establish the conditions, capabilities, and prospects for introducing these models that introduce artificial intelligence as an assisted study tool in spatial learning environments. The implications of proper use of artificial intelligence and access modalities for virtual education are analyzed; therefore, variables that define impact and scientific relevance are generated. It discusses how artificial intelligence can improve or impair the capacity for design generation based on a sequentiality of processes within the algorithm. It is concluded that controlled models should be generated, specifying each algorithm indicator, thus improving students' spatial learning experience.

Keywords: Artificial intelligence, educational model, academic performance, scientific review.

INTRODUCTION

Divergences in education today offer new possibilities for communication, collaboration, interaction, and authentic student-centered learning. Examining the potential impact of new educational environments has become an important aspect of educational researchers' efforts. Much of this research and literature on information and communication technologies (ICT) and learning has been conducted through the lens of sociocultural theories and theories about dialogism (Cook-Chennault & Farooq, 2024).

Social inclusion requires new ways of teaching, communicating, and also challenges students' skills to deal with their own forms of knowledge. The concept of teaching is defined as a specific form of communication that aims to provide students with the opportunity to learn and construct knowledge; however, this presents new challenges for both students and teachers. It represents inherent complexity, partly in the system and partly in the system's environment. Therefore, educators must learn to manage both complexity and contingency.

Through recent literature, results and implications of the ways in which complexity and contingency can affect teaching and learning can be evidenced. Based on learning potential, the digital education model can be characterized, which has currently been established as a teaching methodology that has promoted inclusion in all senses both in virtual classrooms, as well as ethnicities and social strata that face diverse conditions. In this sense, digital education has opened an accessible instrument for most populations that during the global COVID-19 pandemic established a distance or programmed education model, which has adopted various modalities such as synchronous and asynchronous.

These study modalities have allowed access to education to be divergent and dispersed, taking as important data access to the main source of this education model, which is the internet. According to the UN (2022), 5.350 billion people, representing 66.2% of the world's population, are internet users. From this data, it has been investigated that access to educational society borders 70 to 72% of this previous percentage.

From the analysis of this report, it can be said that the digital education model still poses a framework of accessibility deficiency to education of 28% worldwide, which does not generate the same opportunities for all students; however, the asynchronous modality has allowed programming and recording classes that tend to be shared and increase this accessibility to education.

Given this apparent success of the digital education model, artificial intelligence has appeared as an assistance tool for the development of student knowledge. Therefore, a relevant interest has emerged towards the education model based on generative artificial intelligence as an assisted learning process that can particularly help improve design capabilities in student spatial learning based on basic, pre-professional, and professional levels of the student that includes basic design, 2D and 3D design, and urban territorial planning.

What is currently visualized as a successful invention or as a boom within contemporary society that has managed different platforms such as Architectures, Maket.ai, and Autodesk Forma (Space maker) to improve performance in their grades. A tangible fact from a simple glance at the grade changes of students who have used a basic MetaAI tool resembles a positive change in performance, but generates a problem in dependency towards platforms and total autonomy without a degree of originality or direct relation to the search object.

MATERIALS AND METHODS

a. INCLUSION OF GENERATIVE ARTIFICIAL INTELLIGENCE MODEL IN HIGHER EDUCATION SYSTEM

Educational inclusion towards total openness of artificial intelligence has raised paradigms within the process and monitoring of how this tool can generate inequality in educational competencies due to technical ignorance, lack of access, or handling of artificial intelligence. This particular innovative development focuses on creating new content, such as text, images, audio, and video, rather than being limited to analyzing or classifying existing data.

This provides an elevated creativity factor and supposes assisted design (Wuo & Paganelli, 2022). The objective of educational inclusion is to ensure that all students have access to high-quality education that meets their individual needs and allows them to reach their maximum potential. This may involve providing additional support and adaptations, such as specialized instruction, assistive technology, and individualized learning plans.

Educational inclusion also emphasizes the importance of creating a welcoming and supportive spatial learning that values diversity and promotes social and emotional learning (Starks & Reich, 2023). This may involve providing professional development to teachers and staff, encouraging parent and community participation, and creating opportunities for students to participate in activities that develop their handling of assisted artificial intelligence.

Ultimately, educational inclusion of artificial intelligence is an ongoing process that requires collaboration and commitment from all stakeholders, including educators, policymakers, parents, and students themselves. By working together to create inclusive learning environments, we can help ensure that all students have the opportunity to succeed and thrive in school and beyond.

In the context of university education, the generative artificial intelligence model refers to improving the student experience by proposing a more participatory panorama that quickly contextualizes the student in dynamic thinking about 2D and 3D design development.

b. THE PANORAMA OF ARTIFICIAL INTELLIGENCE IN HIGHER EDUCATION LEARNING MODEL

Taking as a case study various higher education units of design careers, a difficulty has been identified when effectively designing architectural elements or innovative proposals by architecture students from various faculties. Despite the disposition and effort of teachers to address this difficulty, educational practice reveals that there are several weaknesses that affect the design process and make it slower and less innovative, with more than a tendency to copy already established designs by students in the pedagogical process.

Among the main deficiencies are insufficient psychological and pedagogical preparation of teachers, lack of capacity to diagnose and adapt learning styles, and poor correspondence between teaching styles and students' learning styles.

The current educational research panorama is characterized by convergence between different epistemological paradigms. Positivism, with its emphasis on objective and quantifiable observation, has historically dominated, especially in studies that seek to generalize results on a large scale, such as in international evaluations (Cohen, Manion, & Morrison, 2011). However, Popperian falsificationism has provided a critical vision by questioning the validity of theories and methodologies through their constant testing and refutation (Popper, 1959).

Given current challenges in education, such as incorporating new technologies and cultural diversity in classrooms, it becomes necessary to rethink ways of researching. This research justifies the need to adopt a combined approach that allows leveraging the strengths of both paradigms to address educational complexity more comprehensively (Schneider et al., 2020).

The use of mixed methodologies in educational research is a response to criticisms that both positivism and falsificationism have faced for their apparent limitation in capturing the totality of educational experience (Flores et al., 2019). In this sense, a methodological approach is proposed that allows not only measuring educational phenomena empirically but also testing pedagogical theories and practices in dynamic and diverse contexts. This combination of paradigms not only guarantees the production of rigorous and replicable knowledge but also favors constant innovation in education (Ben Mahmoud-Jouini et al., 2016).

c. ARTIFICIAL INTELLIGENCE APPLIED TO SPATIAL LEARNING

Artificial intelligence (AI) is increasingly transforming architectural design by introducing new tools and methodologies that enhance creativity, efficiency, and precision (Grau & Maldonado, 2023). The following are some keyways AI is applied in architectural design:

- **Generative Design**: AI algorithms can generate multiple design options based on a set of parameters and constraints provided by the architect (Qin et al., 2024). This process, known as generative design, allows architects to explore a wide range of design possibilities and optimize various factors such as aesthetics, functionality, and sustainability.
- **Optimization and Simulation**: AI can optimize design elements to achieve energy efficiency, structural integrity, and environmental impact. Machine learning models can simulate how a building will behave under different conditions, helping architects make decisions in design phases.
- **Automation of Repetitive Tasks**: AI can automate routine tasks such as drawing, 3D modeling, and construction documentation (Gao et al., 2023). This allows architects to focus more on creative aspects of design and less on repetitive manual tasks.
- **Smart Building Systems**: AI is used to design and manage smart buildings that can adapt to occupants' needs. These systems can optimize lighting, heating, and cooling based on real-time data, improving comfort and energy efficiency.
- **BIM (Building Information Modeling)**: AI enhances BIM by providing more accurate and

intelligent data analysis. AI algorithms can analyze BIM data to identify potential problems, suggest improvements (Khan et al., 2020), and ensure projects are more efficient.

- **Urban Planning and Development**: AI helps in urban planning by analyzing large datasets to predict future trends, optimize land use, and design sustainable urban environments. It can help planners create cities that are more livable, efficient, and resilient.
- **Virtual Reality (VR) and Augmented Reality (AR)**: AI-powered VR and AR tools allow architects and clients to visualize and experience designs in a more immersive way (Golafshani et al., 2024). This can improve communication, reduce misunderstandings, and lead to better design outcomes.
- **Historical Data Analysis**: AI can analyze historical data from previous projects to identify patterns and insights that can inform new designs. This can help architects avoid past mistakes and leverage proven design strategies.
- **Client Interaction and Personalization**: AI can help understand client preferences and needs by analyzing their feedback and behavior (Hosseini Khorasani et al., 2024). This can lead to more personalized and client-centered designs.

d. METHODOLOGY

The research is carried out through a systemic review of high-impact articles in the scientific databases Scopus and ScienceDirect, structuring an interrelational graph of gaps and positive influence of artificial intelligence influence on the digital educational model. These data were systematized in AnalizeSearch and Analytics to obtain the annual impact of publications and determination of indicators that contribute to spatial learning development in student performance.

The hermeneutic method was employed where a 10-year regression of artificial intelligence in educational models was made. For this, texts from representative authors in the global context were selected, their impact, type of contribution, and relevant contribution by authors. These data were relevant to analyze their citation index and impact, generating a correlation of variables such as the digital educational model and artificial intelligence.

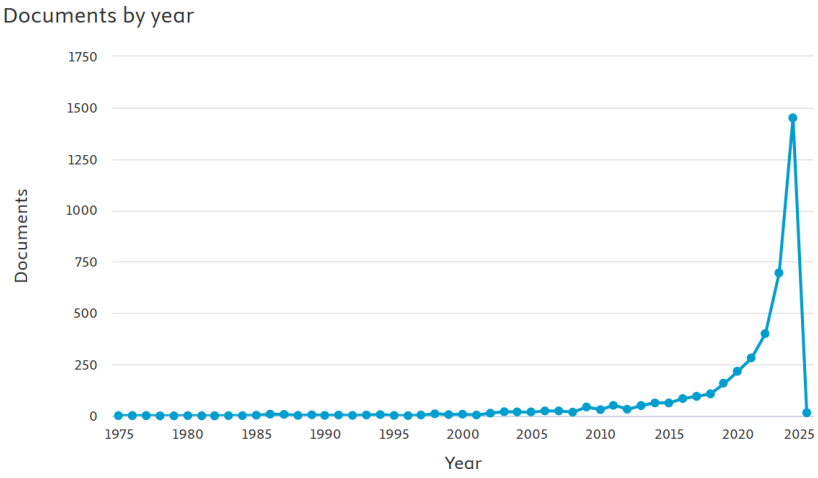
Two phases of bibliometric analysis of information were developed on the PRISMA 2020 and VOSViewer platform to generate a verification list and impact graphics for abstraction of relevant results from the application of the generative artificial intelligence model in spatial learning focused on student performance at higher education level.

RESULTS

1. Systematization of Bibliographic Review

The analysis is performed with the hermeneutic method where a historical regression of all years of scientific review was established, detailing that since 1975 it was a topic to be addressed by researchers of the time, which involves 3 scientific contributions that to date amounts to the development of 9,324 scientific documents.

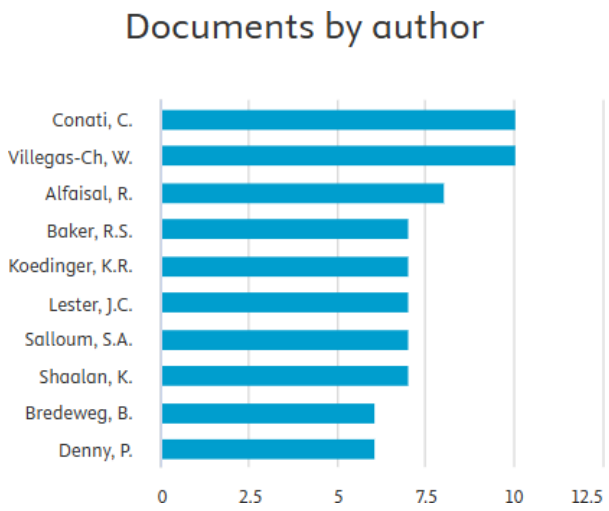
Figure 1. *Systematization of the bibliometric review of AI scientific documents*



Source: *Own elaboration*

It is noted that since 2015 there has been an increase in the introduction of artificial intelligence from the field of robotics to its perennial implementation in virtual education models, generating an upturn of more than 89% in the use of artificial intelligence by students at the level of Latin America, United States, and especially in China.

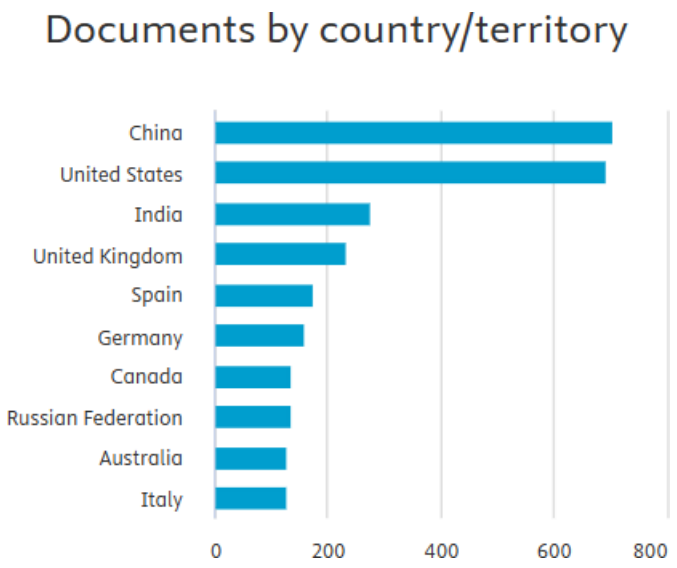
Figure 2. *Search by author for the number of publications related to AI*



Source: *Own elaboration*

As authors, the one with the most influence is Conati C., who focuses on the influence of proper use of artificial intelligence as a study tool, where the relationship between virtual education and artificial intelligence for critical thinking development is emphasized.

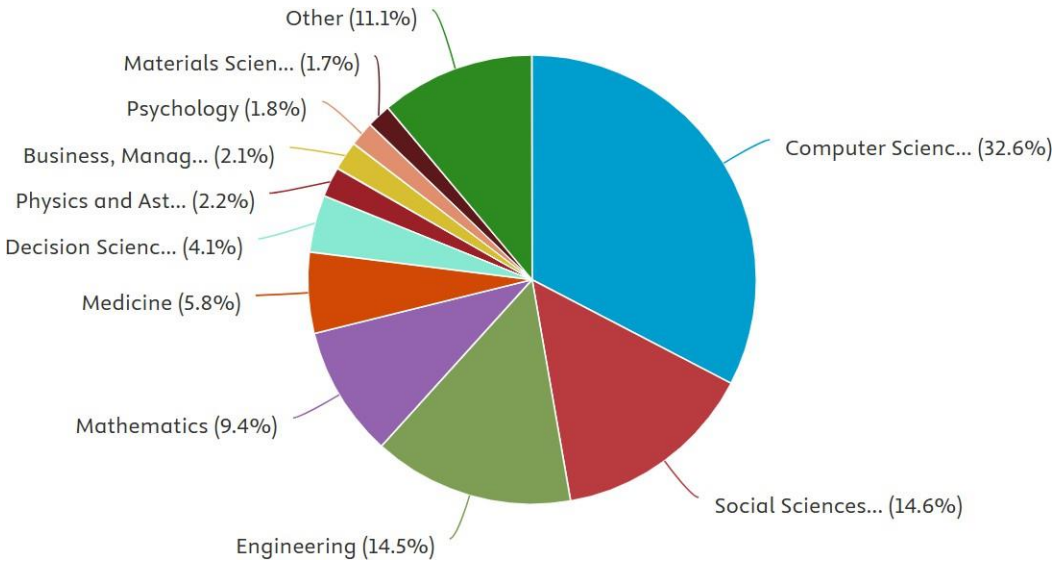
Figure 3. *Search by country for the number of publications related to AI*



Source: *Own elaboration*

As influence, China is the precursor of generating articles related to artificial intelligence, specifying that there are broad challenges for action from the perspective of ethics and epistemological development and innovation of university students.

Figure 4. *Search by academic field for publications related to AI*

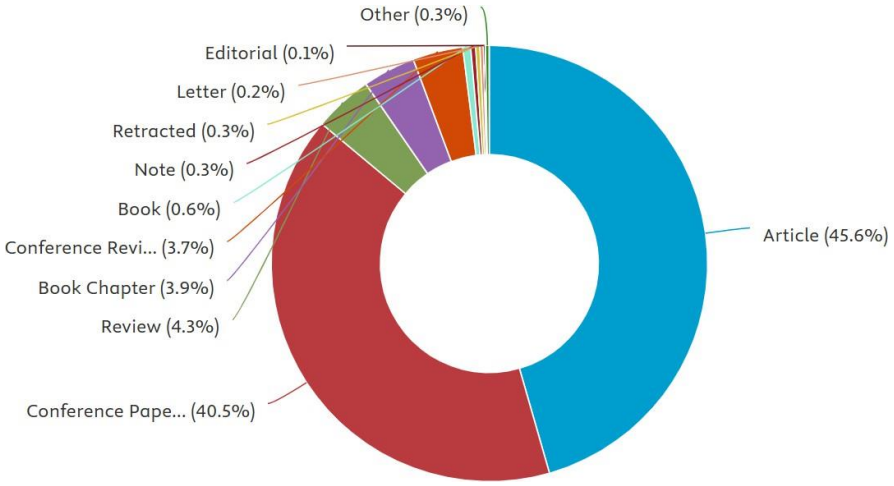


Source: *Own elaboration*

As part of the bibliographic review, typical and atypical data of artificial intelligence in the educational model were generated, noting that computational sciences lead the development of AI in higher studies, while

social sciences as atypical data have expanded their influence in AI use, allowing recognition that the search for general culture or basic knowledge information is also being influenced by artificial intelligence.

Figure 5. *Types of scientific documentation related to AI*



Source: *Own elaboration*

Finally, it can be obtained that the greatest influence of publications is guided by article publications and conference papers that globally generate a production of 3,491 documents vs. development until 2025 of 4,867 scientific documents, giving a breakthrough focus from 2020 of more than 67%. From these data, an iteration of two key phrases in Scopus and ScienceDirect searches could be obtained: proper use of artificial intelligence and relationship of artificial intelligence in robotics.

2. Relationship with Generative Artificial Intelligence Model Evaluations

Among the key evaluations of the digital education model and the use of artificial intelligence, it was considered that they respond to an education variable. Starting from this premise, the ranking is evaluated through an interrelation between Scopus scientific database analysis and SJR measuring the number of citations, H Index.

In this relationship range, it is obtained that "Digital game-based learning: Towards an experiential gaming model" (Kiili, 2005), as article with the highest citation level with 1,078 times in Scopus (98th percentile) and an H Index/FWCI of 9.00; it is detailed as atypical data since the article is based on game development for digital learning as experimental method for traditional learning, which makes the tendency fall on how the dynamics of virtual education exposure occurs through interaction (games).

In this relationship range, it is obtained that "Machine learning: Trends, perspectives, and prospects" (Jordan & Mitchell, 2015), as article with the highest citation level with 5,945 times in Scopus (98th percentile) and an H Index/FWCI of 8.25; it is detailed as typical data since it starts from a maximum publication trend of 2015 and is based on trends, perspectives, and prospects of learning towards managing artificial intelligence to assist the student (tool).

Comparatively, the artificial intelligence development trend has greater acceptance in the digital education model since AI has become an operational tool and execution game, which suggests that the current education model is linked to operation/execution within the digital education methodology.

3. PRISMA 2020 Analysis

To systematize and obtain final results from the scientific article review process, the PRISMA 2020 declaration was employed (including indicator lists and variables within the search flow), where all review articles from the complete search list including 9,324 items were included, some of which include subtopics corresponding to study indicators defined by keywords "digital education model" and "artificial intelligence." Structured abstracts of systematic reviews presented in journals and conferences were included (Page et al., 2021).

Table 1. *PRISMA 2020 analysis of AI*

PRISMA 2020 Main Checklist

TITLE			
Title	1	Identify the report as a systematic review.	artificial intelligence
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	digital education model
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Measure the good use of artificial intelligence
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	usage dependency
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Scopus
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	education
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	peer review
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	independent researchers
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	data analysis
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	citation index
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	review not applied
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	relevant investigations
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item 5)).	tabulations
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	statistics
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	standardization of the mean
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	meta-analysis
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	meta-regression
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	number of publications
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	data collection
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	deductive method
RESULTS			

Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	article review
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	cited studies
Study characteristics	17	Cite each included study and present its characteristics.	educational studies
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	plagiarism
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	credible interval
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	author contributions
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	credible interval
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	published results
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	published results
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	credible interval
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	credible interval
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	credible interpretation
	23b	Discuss any limitations of the evidence included in the review.	study limitations
	23c	Discuss any limitations of the review processes used.	study limitations
	23d	Discuss implications of the results for practice, policy, and future research.	policy limitations
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	registration number
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	review protocol
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	review
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	non-financial support
Competing interests	26	Declare any competing interests of review authors.	most cited
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	public

PRIMSA Abstract Checklist

TITLE			
Title	1	Identify the report as a systematic review.	Yes
BACKGROUND			
Objectives	2	Provide an explicit statement of the main objective(s) or question(s) the review addresses.	Yes
METHODS			
Eligibility criteria	3	Specify the inclusion and exclusion criteria for the review.	Yes
Information sources	4	Specify the information sources (e.g. databases, registers) used to identify studies and the date when each was last searched.	Yes
Risk of bias	5	Specify the methods used to assess risk of bias in the included studies.	Yes
Synthesis of results	6	Specify the methods used to present and synthesize results.	Yes
RESULTS			
Included studies	7	Give the total number of included studies and participants and summarise relevant characteristics of studies.	Yes
Synthesis of results	8	Present results for main outcomes, preferably indicating the number of included studies and participants for each. If meta-analysis was done, report the summary estimate and confidence/credible interval. If comparing groups, indicate the direction of the effect (i.e. which group is favoured).	Yes
DISCUSSION			
Limitations of evidence	9	Provide a brief summary of the limitations of the evidence included in the review (e.g. study risk of bias, inconsistency and imprecision).	Yes
Interpretation	10	Provide a general interpretation of the results and important implications.	Yes
OTHER			
Funding	11	Specify the primary source of funding for the review.	Yes
Registration	12	Provide the register name and registration number.	Yes

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. MetaArXiv. 2020, September 14. DOI: 10.31222/osf.io/v7gm2. For more information, visit: www.prisma-statement.org

Source: *Own elaboration*

4. VOSViewer Analysis

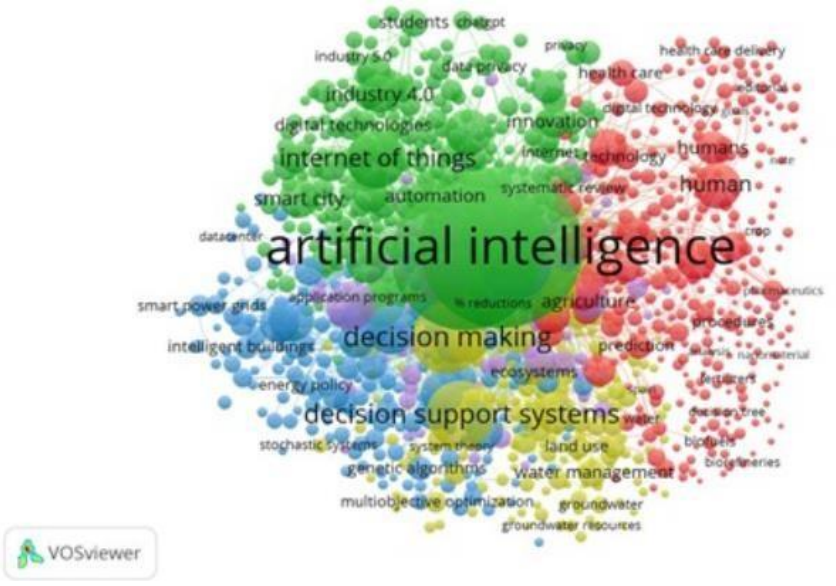
In the second stage, a bibliometric analysis was performed to examine research trends at the intersection of AI, generative models, and spatial learning during the 2015-2025 period. For this, Scopus and ScienceDirect databases were used, selected for their broad scope and recognition in the academic community. Specific keywords related to AI were defined to retrieve relevant documents, so the search was divided into two concurrent fields that allowed better visualization of knowledge and learning of the generative artificial intelligence model.

Table 2. *Search strategy*	
AI AND knowledge	**AI AND impact**
(TITLE-ABS-KEY (artificial AND intelligence) AND TITLE-ABS-KEY (generative model AND special knowledge)) AND PUBYEAR > 2015	(TITLE-ABS-KEY (artificial AND intelligence) AND TITLE-ABS-KEY (good use AND impact)) AND PUBYEAR > 2015

Source: *Own elaboration*

The visualization was managed as a chain of interrelationships around scientific searches and two variable groups: artificial intelligence in knowledge and artificial intelligence and its impact.

Figure 6. *VOSViewer analysis of AI*



Source: *Own elaboration*

DISCUSSION

Critique of Artificial Intelligence Supplantation in Scientific Knowledge

It can be rescued from this critique that proper use helps improve learning and research techniques; however, its misuse can lead us to total dependency and halting of scientific knowledge. The design of statistics in educational centers such as that developed in the Faculty of Architecture and Urbanism of the University of Guayaquil has generated an important glimpse in which modern educational processes are questionable and approved at the same time, which is a paradigm between contemporary positivism and falsifications since both philosophical positions can converge and not give total or partial reason to one of them, but become transformational.

The conception of artificial intelligence should not deviate from the fact that it is a reality and humanity's own creation which should remain under its control, which should not become unbalanced since it cannot be totally autonomous; but thanks to this transformation and evolution it has demonstrated the ability to make its own decisions that in the long run will not be ethical or humanizing that would affect the perception of good and evil in terms of an axiom.

From this important point of action, hermeneutics as the art of interpretation is the key to knowing how to learn from artificial intelligence so that the techniques of its use and the methodology of its functioning are understood and interpreted conveniently without stopping scientific knowledge and autonomous advancement of educational societies. It is of primary importance to maintain innovation and good research practices to generate agents of change and not dependents.

The limitations of artificial intelligence make the model very dependent on quality data translated into performance variables, so a compound algorithm can generate a definition of the design reality required and a specific choice of urban context, for which AI algorithms are only as good as the data they receive. Incorrect or incomplete data can lead to erroneous results.

As the main concern generated by AI, ethics and systematic evaluation of knowledge is questionable since identification elements still in the Latin American educational system and in influence with the case study do not allow perceiving the limit of artificial intelligence application and how far it is known that the student has generated new knowledge or is emulated by AI or assisted robotics.

In summary, while AI offers interesting possibilities for improving education, it also raises serious ethical, social, and practical concerns. Addressing these criticisms involves finding a balance between leveraging technology to improve education while ensuring equity, privacy, and preserving human elements of teaching.

CONCLUSION

The results affirm that the use of artificial intelligence generates great interest by the scientific community since it surpasses with 5,945 citations the scientific contributions of digital education models with 1,078 citations, which attributes that the field of technological innovation and social sciences generate an important contribution to this type of literary review. The contributions of artificial intelligence in digital education models have precedence since 1975, which attributes that it is not a new science but in constant reconformation. The view of how it evolves and develops has generated special interest since in just 10 years of literary review they have generated more than 80% of contributions at a general level having as means of dissemination scientific articles of operation and execution of educational models using artificial intelligence technologies.

Through PRISMA 2020 analysis, it could be verified with respect to the 27 variables entered for data processing that contributions in artificial intelligence propose a rising trend in this new year 2025, which can remain stable and generate new relevant contributions to assisted robotics and the ability to adopt artificial intelligence from the perspective of advanced science and that can be a new teaching model determining a correct methodology, use, and estimation of scientific knowledge generated to promote content deduction.
However, dependency and lack of deductive interest in the knowledge being generated could lead to a limitation of critical thinking and student autonomy, generating a halt in the knowledge curve, expanding AI dominance over general knowledge and not promoting more specialized cognitive development in generating critical professionals. Therefore, knowledge preservation should have usage limitations regarding generative artificial intelligence, establishing usage and handling regulations that avoid altering ethics and development of new knowledge.

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