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Trends in Artificial Intelligence and Education Research: A Preliminary Scientometric Analysis in Scopus

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ABSTRACT

This study presents a preliminary scientometric analysis of research on Artificial Intelligence (AI) and education, aiming to characterise the global scientific output in this emerging field. After removing duplicates and erroneous records, a total of 8,755 documents (articles, reviews, book chapters, and conference proceedings) indexed in Scopus were analysed. The research was structured in five phases: data collection, extraction, analysis, visualisation, and interpretation. Variables examined included temporal evolution, document typology, geographical distribution, language, open access modality (OA), funding, institutional affiliation, publishers, citation by categories, and compliance with the laws of Price (1963), Bradford (1985), and Lotka (1926). Results indicate that over 75% of the production occurred between 2020 and 2024, positioning the field in a precursor phase (Price, 1963). Scientific articles predominate (87%), followed by reviews (4.93%) and conference proceedings (2.90%). The United States, China, and the United Kingdom lead research output, with English remaining the dominant language. More than 50% of records correspond to Open Access Gold (OAG) publications, concentrated in ten publishers. Most studies do not declare funding sources, and research is dispersed across non-specialised journals. Overall, the data reveal a rapidly expanding field with limited editorial specialisation and low transparency in funding practices, highlighting the need for stronger disciplinary consolidation and greater scientific openness at the intersection of AI and education.

Keywords: Artificial intelligence, Education, Research trends, Indexing, Quantitative analysis.

INTRODUCTION

As industrial processes accelerate, new medicines are discovered and the automation of tasks in various areas of daily life is perfected, it is undeniable that the development of Artificial Intelligence (AI) will also have a significant impact on learning. The United Nations Educational Scientific and Cultural Organisation (UNESCO) points to it as a valuable resource for addressing the educational challenges and implementing educational practices of our era (2024). Meanwhile, the latest report from the Digital Education Council (Bielik & Rong, 2025) confirms that AI is very useful and even revolutionary for productivity in teaching (p.7).

Some authors (González-González (2023; Roll & Wylie, 2016) consider that this technology has transformed education due to its ability to change the teaching paradigm. Among the applications of AI in education are intelligent tutoring systems (García-Peñalvo et al., 2024), personalised learning, data analysis and, more recently, the potential of generative AI (García-Peñalvo et al., 2024; Solís et al., 2023).

In the field of education, in addition to ensuring the safe use of artificial intelligence (García-Peña et al., 2020), it is essential to address other key challenges such as privacy protection, user experience and equity in access to education. These issues have been addressed by initiatives such as the Beijing Consensus on AI and Education (United Nations Educational, 2019), especially in light of the emergence of AI systems capable of automatically generating content. To advance ethical, efficient, and high-quality implementation in education, it is necessary to analyse aspects such as the risk of bias in the data used to train these systems (Galdames, 2023), as well as issues related to their governance (Bielik & Rong, 2025; Akgun & Greenhow, 2022; Nguyen et al., 2023). Some authors have even proposed indicators for consistent application in areas where AI is involved (So & Ahn, 2022). Bielink and Rong (2025) also warn of the danger of the growing gap between market demands and what education systems offer, undeniably requiring collaboration between schools, the market and governments.

This technological tool joins others that seek to address current educational challenges, such as strengthening digital skills and creativity, key skills for the 21st century. Authors such as (Mayer et al., 2025) believe that the transformative potential of AI is comparable to that of the Industrial Revolution and could surpass previous technologies such as the Internet. Dawson et al. (2023) believe that there is a whole new educational landscape that can be reinforced through the use of AI, which should focus on creative thinking and problem solving. For all these reasons, the use of AI should be considered as a support for advancing these skills in students (Aparicio-Gómez, 2023; Parra-Sánchez, 2022) in the same way that it can provide valuable information for those responsible for changes in educational policies (Bonami et al., 2020).

Therefore, it is necessary to understand the state of AI in relation to education in academic and evidence-based research terms, which provide a solid basis for analysis and decision-making. One way to do this is through a preliminary scientometric analysis capable of recognising such evidence recorded on actual trends in research on this topic. A scientometric analysis measures and analyses surveyable data on a given issue, providing insight into the state of the art and thereby facilitating data-driven strategic decision-making (Arencibia et al., 2008; Callon et al., 1995). In the case at hand, this preliminary analysis will be carried out using the SCOPUS database due to its academic, rigorous and renowned approach to the classification and indexing of scientific literature in the field of social sciences and education.

This study was developed in response to the need to answer the following research question: What is the state of scientific production on AI and education in the SCOPUS database since records began?

Thus, the objective of the research will be: To develop a current scientometric analysis of AI and education in the SCOPUS database up to the year 2024.

This will enable us to answer the above research question and plan and optimise various theoretical and empirical studies related to the topic. However, in order to consistently achieve the overall objective, we need to proceed with the achievement of several specific objectives:

OE.1: To verify compliance with the Law of Exponential Growth of Scientific Information (Price 1963) with a study on the temporal evolution of publications on AI and education.

OE.2: To examine the geographical distribution of scientific research related to the subject in question up to the date indicated.

OE.3: To examine the linguistic distribution of scientific publications worldwide on the subject.

OE.4: To analyse the records extracted by their open publication type.

OE 5: To analyse in detail the scientific output on the subject of this study using the SCOPUS database.

OE 6. To examine the institutional affiliations of the authors, identifying the participating study centres and research entities.

OE 7: To develop a study on the origin of funding and the institutions that support AI research in the field of education.

OE.8: To conduct a citation analysis of the ten most cited articles, reviews, and proceedings up to the year 2024.

OE.9: To assess the degree of compliance with the law of dispersion of scientific literature, formulated by Bradford (1985) in the period analysed.

OE.10: To analyse the applicability of the productivity law of authors, proposed by Lotka (1926), in the context of publications on education and artificial intelligence within the study period considered.

METHODOLOGY

To quantify publications on AI in education in the SCOPUS database, the methodology of Michán and Muñoz-Velasco (Page et al., 2021) and the PRISMA Methodology workflow diagram (Page et al., 2021) were adapted, ultimately structuring the process into five stages: data collection, information extraction and screening, descriptive analysis, results visualisation, and interpretation of findings.

- In the collection phase or first phase, the sources were selected, the resources were chosen, and the information was researched and selected.
- In the second phase or extraction phase, the most relevant data was collected and filtered for refinement and subsequent processing.
- In the analysis phase or third phase, descriptive analyses of the scientometric study were prepared, taking into account the indicators proposed in the objectives.
- In the fourth phase or visualisation phase, the parameters, graphs, and visual representations related to the analysis were extracted.
- In the fifth phase or final interpretation phase, the results obtained were described, compared, and contextualised.

POPULATION AND SAMPLE

The total population of scientific literature indexed in the SCOPUS database up to 2024 was 9,431 records. After removing duplicates and errors, this was reduced to 9,185. Applying the inclusion and exclusion criteria determined below, the convenience sample was limited to 8,755 index entries in the SCOPUS database. Boolean operators were used to select studies, combining various terms found in the title, abstract, and keywords. The terms were: Artificial Intelligence, AI, machine learning, Deep learning, neural networks, education, educational technology, e-learning, online learning, blended learning, adaptive learning, and learning analytics.

PROCEDURE

First, the research question was posed and the objectives, both general and specific, were formulated. In phase 1 of the data collection, a search was conducted in the SCOPUS database with the aim of obtaining a preliminary quantitative overview of the indexed records, anywhere in the title, abstract or keywords.

Boolean terms such as AND and OR were also used to find relevant information, resulting in the following search string: (TITLE-ABS-KEY ('artificial intelligence' OR "AI" OR 'machine learning' OR 'deep learning' OR 'neural networks') AND TITLE-ABS-KEY ('education' OR 'educational technology' OR 'e-learning' OR 'online learning' OR 'blended learning' OR 'adaptive learning' OR 'learning analytics').

The inclusion criteria considered for screening were:

- Scientific output should be included in the entire database from the earliest records available up to 2024.
- Output should be limited to the Social Sciences and Multidisciplinary areas.
- Indexed scientific output should be limited to articles, book chapters, conference proceedings, and reviews.
- The following items were considered exclusion criteria:
- Records were made after the start date of the research.
- No articles in the process of publication were taken into account.
- Scientific output was not openly available.
- Figure 1 shows the filtering and refinement of data in its initial phase based on the PRISMA workflow (Page et al., 2021).

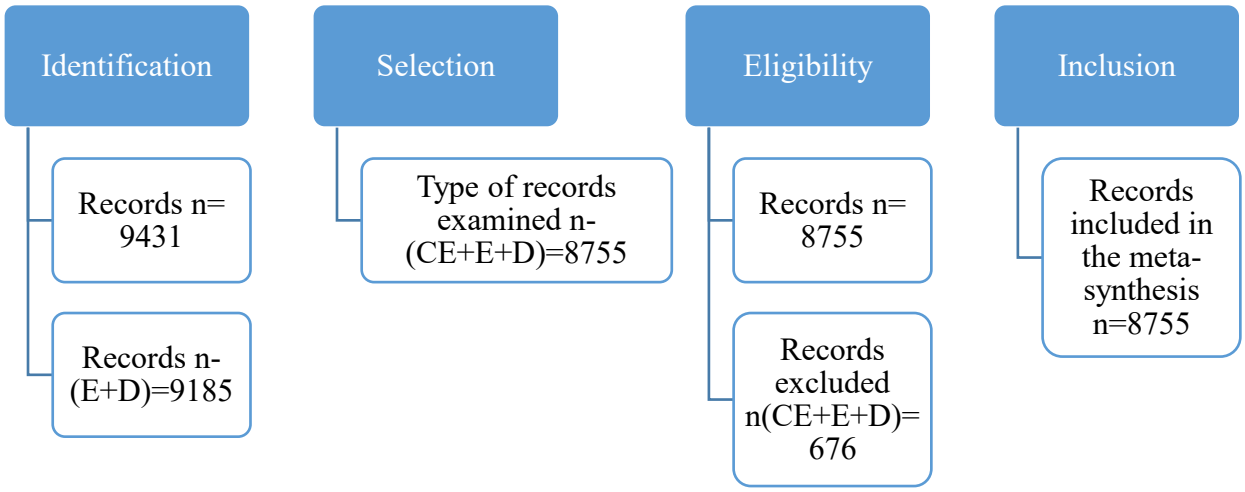

Figure 1. Records for scientometric analysis in SCOPUS until 2024.

Note. Adaptation of the PRISMA workflow (Page et al., 2021). E=errors. D=duplicates. CE=exclusion criteria.

In a second stage or phase 2, after applying the inclusion and exclusion criteria and eliminating duplicates by title and DOI number, the records were limited to a total of 8,755. Table 1 shows the classification by type of document to which the scientometric analysis will be applied.

Table 1. Type and number of records extracted from SCOPUS until 2024.

Record type	Nº Records
Articles	8027
Chapters	9
Conference proceedings	266
Reviews	453
Total	8755

Note*:* Own elaboration.

In phase 3 of the analysis, the above indicators were taken into account, along with various types of records that could be analyzed depending on the case and the specifications that would be used to achieve the proposed objectives.

Table 2 shows the list of indicators, types of records, and specifications to be analyzed with their corresponding specific objective.

Table 2. Analysable indicator, record type and specifications to be analysed in SCOPUS until 2024.

OE	Analysable indicator	Analysable records	Specifications
OE1	Chronological production	Total Re	0-2024 Application of the exponential growth law (Price, 1963) 15 years
OE2	Geographical distribution	Total	Top ten productive countries
OE3	Language production	A/R/Proc./Chap.	Total
OE4	Producción por tipo de Open Access (OA)	A/R/Proc./Chap.	All, Gold/Green/Gold
OE5	Publishing production	A/R/Proc./Chap.	Top Ten publishers
OE6	Production by affiliation	A/R/Proc./Chap.	Top Ten affiliations
OE7	Output by funding body	A/R/Proc./Chap.	Top Ten Funding Body
OE8	Output by citation	A/R/Proc./Chap.	Top Ten cited articles
OE9	Bradford's Law	A/R/Proc./Chap.	Compliance with the law of dispersion of scientific literature.
OE10	Lotka's Law	A/R/Proc./Chap.	Compliance with author productivity. Elite scientific producers

Note: Own elaboration. Total production (Total)/ A (Articles)/R (Reviews)/Act (Conference Proceedings)/Cap (Book Chapter)

In phase 4 of visualization, all the information was structured in an Excel data matrix to produce the graphs and tables needed to enrich the textual information analyzed.

In the final phase, phase 5 or interpretation, the results and their interpretation were described to verify or discard the scientific patterns analyzed. This phase also included a discussion of the findings to draw plausible inferences (Gingras, 2016) and verification of the degree to which the proposed objectives had been achieved. This phase culminated in the contribution of the most important discoveries for the subsequent process of informed or data-based decision-making.

RESULTS

Overall Chronological Production

The types of records analysed include scientific articles, book chapters, conference proceedings, data articles, editorials, notes, retraction articles, letters to the editor, and brief reviews. This represents a total of 9,431 entries in the database analysed up to 2024. After cleaning and screening, the total number of records was 9,185.

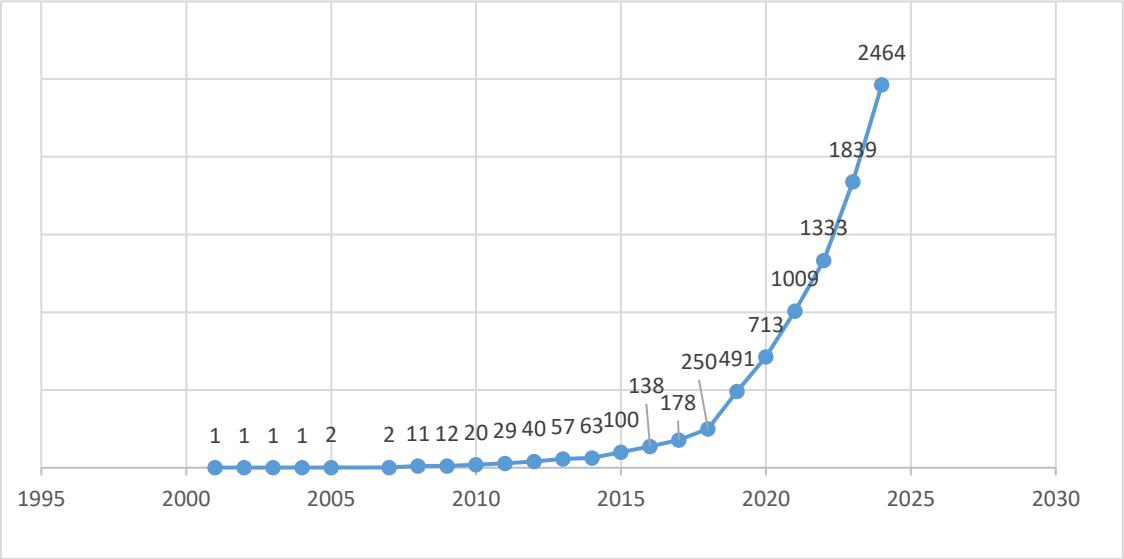

Figure 2. Global scientific literature production in SCOPUS on AI and education until 2024.

Note. (Since records began). Own elaboration.

Until 2024, scientific articles are the predominant type of publication, accounting for 87.39%. In second place, and far behind, are review articles, accounting for 4.93%. In third place are conference proceedings, accounting for 2.90% of the records. In last place are book chapters, whose volume is currently residual and whose percentage represents barely 0.10% of the scientific literature recorded.

Total Chronological Production by Type of Record of Interest

The chronological production of articles, reviews, proceedings, and chapters is analysed for its rigour and quality from a total of 8,755 records, limited to articles, reviews, proceedings, and book chapters, with 15.95% indexed up to 2019. From 2020 to 2024, 84.04% will be indexed.

The figure 3 shows the total records of scientific production in the SCOPUS database related to the subject matter up to 2024, which will be analysed in reference to the selected data type in order to verify compliance with the Price Act (1963).

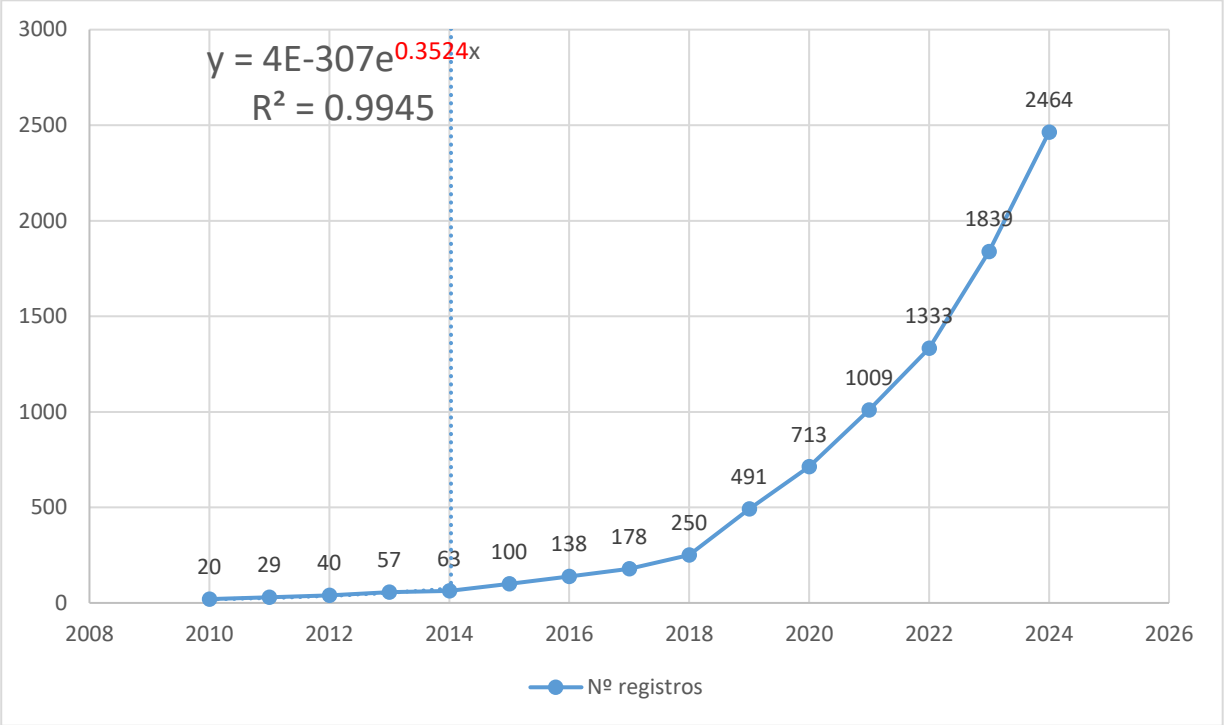

Figure 3. Scientific literature production in SCOPUS 2010-2024.

Note*:* Own elaboration.

If we apply the formula $\boldsymbol{NF = N_0 e^{rt}}$ se observa si we can see whether this law holds true for the 2010-2024 time frame.

Where NF is the expected population on the final date (X) and N0 is the existing population on the initial date (20), and taking into account Euler's number (e) as a fixed exponential base whose value is invariable (2.718281828), taking r as the growth rate (0.3524) and t being the time elapsed from the initial date to the final date in years (15), it can be deduced that the number of records expected in 2024 would be 3927. The data collected from the SCOPUS database shows that we are still far from reaching the exponential phase expected by the law of exponential growth (Price, 1963), thus indicating that the subject is in its early stages

Chronological Production by Document Type

The analysis will be limited exclusively to the following types: articles, reviews, conference proceedings, and book chapters, given that these types meet scientific quality criteria, as it is widely known that these records are subject to rigorous screening prior to publication and must comply with standardised items recognised and accepted by the research community as a whole.

a) Artícles

Articles are the most voluminous type of record on the subject in SCOPUS, relating AI to the field of education, accounting for 87.39% (8,027) of indexed records.

b) Reviews

In the case of reviews, we can say that, of the total indexed production since 2012 for this type of record in SCOPUS, this category of records accounts for 4.93% (453). This is well below the previous category.

c) Conference proceedings

For their part, conference proceedings, first recorded in SCOPUS in 2010, account for 2.90% (266) of all records related to the subject.

b) Book chapters

With regard to book chapters, since 2014 only a residual percentage of 0.10% has been recorded (9).

Table 3. Registration of articles, reviews, conference proceedings, and book chapters on AI and education in SCOPUS until 2024.

Document type	Nº records
Article	8027
Reviews	453
Conference proceedings	266

Book chapters	9
Total	8755

Note*:* Own elaboration

Geographical Distribution

Taking into account the production of open scientific literature by country, out of a total of 8,755 records, we can highlight that, of the 144 countries of origin of the publications, the 10 with the highest production in the categories mentioned account for 72.51%, with the top three being: the United States (18.54%), China (14.88%) and England (7.13%).

Below these countries we find Germany (5.68%), Spain (5.23%), India (4.77%), Australia (4.58%), South Korea (4.07%) and Saudi Arabia (3.95%). Canada (3.68%) ranks last in the Top Ten.

Language Production

By language, a total of 27 languages have been registered in SCOPUS globally. The most widely used languages are, in order: English, Spanish, Russian, Portuguese and Italian, with ten or more documentary indexations per language in the case of articles. In the case of reviews, only English exceeds the publication of more than 10 units per language, as do proceedings and book chapters. English stands out, in line with the norm to date, in all the types of publication recorded: 95.08% of articles, 96.91% of reviews, 98.97% of proceedings and 100% of book chapters.

Production by Type of Open Access (OA) Publication

The study database offers the possibility of filtering the type of records according to whether they are OA (Open Access) licences, with four subtypes: Gold (open and immediately accessible to readers), Green (the author has a copy in an institutional repository), Hybrid Gold (subscription journals that offer the option of publishing some articles openly for readers) or Bronze (articles published in free-to-read journals, but with no guarantees for authors). In the case study, the types are reduced to Gold Open Access (GOA) and Gold plus Green Open Access (OA2G). Of the total of 8,027 articles with this type of licence, 52.59% of the article records are classified as Gold and 47.41% are classified as Gold and Green.

In the case of reviews, of the total of 298, 65.78% are published in Gold format and 34.22% in Gold and Green formats.

With regard to conference proceedings, of the total of 164 records, 61.65% are in Gold format and 38.35% in Gold and Green format. Meanwhile, 100% (9) of book chapters are available in Gold format.

Publishing Production

Of the 9,185 records indexed in Scopus, 645 publishers or publishing groups linked to publications on artificial intelligence and education were identified. Articles represent 50.33% (4,406) of the total, concentrated in ten publishers that account for 48.91%. The remaining 1.42% corresponds to unregistered publishers or independent publications. Public Library of Science and Nature Research stand out, with 11.38% of the total production each and 12.41% within the article category.

Reviews (453) are distributed among 105 publishers, equivalent to 5.17% of the records. MDPI stands out, accounting for 0.73% of the total and 14.13% of reviews. Conference proceedings (266) constitute 3.04% of publications, edited by only 12 entities. The top ten account for 2.86% of the total and 98.87% of their category. The International Society for Photogrammetry and Remote Sensing stands out, with 2.19% of total production and 72.18% of the proceedings. As for book chapters, only two publishers contribute 0.09% of the scientific production analysed. It should be noted that 1.54% of articles, 0.02% of reviews and 0.21% of conference proceedings lack editorial support, a situation not observed in book chapters.

Production by Funding Entity

For scientific production and research, it is important to have financial backing that provides economic compensation for the time invested. In this case, these funding entities or sponsors have been practically non-existent or unknown. Out of a total of 8,755 records, only three conference proceedings have been found that have declared the funding of the study being carried out, representing 0.03% of the total records in any of the categories and 1.12% of the classification to which they belong (proceedings).

Production by Affiliation

To determine the volume of records of interest (articles, reviews, conference proceedings, and book chapters related to institutional affiliations), we will extract the data. Table 4 shows that, of the total number of records, the highest volume of affiliated production is in articles, with 91.56% of them being by authors affiliated with an entity,

department, or research institute. Only 0.13% are records published by unaffiliated researchers or whose affiliation is unknown due to a lack of recorded evidence. The authors of the remaining records (reviews, proceedings and book chapters) are 100% affiliated with research institutions.

Table 4. Type of record with and without affiliation until 2024.

Document type	With membership	Without membership
Article	8016	11
Reviews	453	0
Conference proceedings	266	0
Book chapters	9	0
Total	8744	11

Note*:* Own elaboration.

Production by Citation

With regard to production by citation, the 10 most cited articles, reviews, proceedings and book chapters since records began up to 2024 in the SCOPUS database will be shown. To obtain information on the most cited record in the field of education, the title of each type was filtered using text containing the suffix truncation educa*.

Artícles

Of the total citations (139,311) for the 8,027 articles, the 10 most cited articles accounted for 7.5% of citations. The most cited article was published in 2017, with a total of 1.95% (2,723 citations) published by PLOS ONE Journal. The title of the article is: SoilGrids250m: Global gridden soil information based on machine learning.

On a specific educational topic, the most cited article was published in 2023 and obtained a total of 0.71% (987) citations.

Reviews

The reviews have received a total of 19,309 citations. The 10 most cited reviews have obtained 30.89% of the total. The most cited review was published in 2019 with 7.99% (1,543) of citations and was published by Springer Netherlands' International Journal of Educational Technology in Higher Education. Its title is: Systematic review of research on artificial intelligence applications in higher education – where are the educators?

In the case of reviews, the most cited overall coincides with being in the field of education.

Proceedings

Of 216 proceedings with a total of 2,232 citations, the 10 most relevant publications in terms of number of citations account for 32.53%. The most cited proceedings were published in 2016 and account for 6.27% of the total citations in their category. They were published by the International Society for Photogrammetry and Remote Sensing and are entitled: S+B2:B257 ingle-image super resolution for multispectral remote sensing data using convolutional neural networks.

In the case of education, the most cited paper, published in 2021, was cited 1.08% of the time and was published by the journal International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives.

Book Chapter

Of the total number of book chapters related to AI and the educational environment, the number of total citations is 11, of which the most cited chapter, published in 2021, was published by Methodology of Educational Measurement and Assessment from the Springer Nature publishing group.

The chapter in question is entitled: Advances in AI and Machine Learning for Education Research and, to date, has obtained 54.55% of citations in its category.

Production of Scientific Literature According to Bradford's law

According to Bradford (1985), scientific production is uneven, which means that the vast majority of publications on a given topic would be published in a very small number of scientific journals. Hence, his formula can tell us which journals are most specialised in a given subject. This is the Law of Scientific Production Dispersion (Bradford, 1985) and, despite being criticised for not taking into account other factors such as periodicity or frequency of publication, it can be taken into account on a preliminary basis to add value to the desired analyses and also to classify journals, conferences or publishers (Cobos et al., 2021; Parra-González & Segura-Robles, 2019). Bradford's dispersion law (1985) identifies three broad zones by degree of specialisation: the core or main zone, zone 2 or intermediate zone, and zone 3 or low specialisation zone. The inclusion of scientific output in each zone

is determined by dividing the total number of the type (articles, journals, proceedings or chapters) by 3 (the three zones). Journals will be shown by zone from the total number of records analysed.

Articles

Of a total of 847 journals that include article-type records in their publications, in the SCOPUS database in this case, the law of dispersion of scientific literature (Bradford, 1985) seems to hold true. The three zones are dominated by three journals producing 34.67% of the articles. Outside the areas of specialisation are 99.65% of journals. It is noteworthy that 333 journals have published only one article, representing 33.31% of the total that have published articles related to the subject matter.

Table 5. Distribution of magazines by production companies according to areas of Bradford. Articles.

Area	**Nº Journals**	**% Journals**	**Articles**	**% Articles**
Core	1	0.12	1103	13.74
Area 2	1	0.12	1071	13.34
Area 3	1	0.12	609	7.59
Outside zone	844	99.65	5244	65.33
Total	847	100.00	8027	100.00
Journals that are part of the core				Nº. Articles
Scientific Reports				1103

Note*:* Own elaboration.

Reviews

With a total of 150 journals, it can be seen that, in the case of reviews, Bradford's Law (1985) also applies, given that in the three zones there is only one journal per zone responsible for publishing 26.93%. Outside the defined area of specialisation, there are 147 journals that publish 73.07% of reviews since records began until 2024. In the core area is the journal Sustainability, with 60 reviews published on the topic of AI and education.

Table 6. Distribution of journals according to the Bradford Law. Reviews.

Area	**Nª Journals**	**% Journals**	**Reviews**	**% Reviews**
Core	1	0.67	60	13.25
Area 2	1	0.67	32	7.06
Area 3	1	0.67	30	6.62
Outside zone	147	98.00	331	73.07
Total	150	100.00	453	100.00
Journals that are part of the core				Nº Reviews
Sustainability (Switzerland)				60

Note*:* Own elaboration.

Proceedings

With regard to conference proceedings, a single conference or publisher of proceedings occupies the top two positions, accounting for 72.18% of all proceedings published since records began up to 2024. In the low specialisation zone, 12 conferences stand out with 27.82% of published proceedings. The ISPRS Archives stands out in the core zone as the publisher of the proceedings.

Table 7. Distribution of producer conferences according to Bradford zones.

Area	**Nº Conferences**	**% Conferences**	**Proceedings**	**% Proceedings**
Core	1	7.69	192	72.18
Area 2	0	0.00	0	0.00
Area 3	12	92.31	74	27.82
Outside zone	0	0.00	0	0.00
Total	13	100.00	266	100.00
Conferences that are part of the core				Nº Proceedings
International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives				192

Note*:* Own elaboration.

Book Chapters

Although the number of book chapters is not a sufficient sample, the trend seems to coincide. The results show that only two journals or publishers that have published in the same book (16.67%) are concentrated in the core area, with the same percentage in area two, where there is only one book or publisher that publishes three chapters, and in the low specialisation area or area 3, there are four books that have published one chapter each, accounting for 66.67% of publications by publishers.

Table 8. Distribution of chapters published in journals or publishing firms.

Area	**Nº. Books**	**% Books**	**Chapters**	**% Chapters**
Core	1	16.67	2	22.22
Area 2	1	16.67	3	33.33
Area 3	4	66.67	4	44.44
Outside zone	0	0.00	0	0.00
Total	6	100.00	9	100.00
Books or publishing firms that are part of the core				Nº Chapters
Knowledge and Space				2

Note*:* Own elaboration.

Scientific Production According to the Law of Author Productivity or Lotka's Law

According to Lotka, there is a high proportion of authors who publish a low number of scientific papers contributing to the same field, yet there are very few authors who are specialists in a specific field (Lotka, 1926).Here we will evaluate whether the distribution coincides with or conforms to Lotka's Law in its original model, where $A_n=A_1/n^2$ or yes, it varies depending on the model, that is, if it complies with the variant formula $A_n=A_1/n^m$

Taking the above into account, the authors' productivity law should have a progression in which m=2. In cases that do not comply with this progression, a logarithmic function is proposed that provides the most accurate prediction value of m, taking into account the point of intersection between actual and expected authors. Similarly, Lotka (1926) also provides the possibility of calculating the elite group of authors, using a production index determined by the logarithm to base 10 of the number of published works. This makes it possible to determine the high (1), medium (0-1) or low (0) productivity of each group of authors. Those who exceed the threshold of 1 would be considered, according to Lotka (1926), as the elite authors in that subject area.

Distribution of Article Producers According to Lotka's Law

A total of 27,774 authors have published articles relating to the subject of education and AI, with a total of 8,027 articles published. It can be seen that, since records began, up to 2024, in the case of this type of record, 68.94% (19,148) of authors have published only one article.

On the other hand, the author who has published the most articles has reached a total of 85 articles on the subject. Due to the extent of the data, we will limit the description of the results to the threshold for considering authors to be elite, which is 1 according to Lotka. In this case, the threshold is for authors who have written a maximum of 10 articles, although it is noteworthy that, in this case, there are authors who have participated in up to 85 publications. As can be seen in Table 10, the authors expected with the adapted formula in which the value of m = 2.27 most accurately approximates the reality of the publications per author that have occurred.

Table 9. Distribution of producers according to Lotka's law. Articles.

		$A_n=A_1/n^2$	**$A_n=A_1/n^m$**
Articles	**Authors**	**Expected authors 1**	**Expected authors 2**
1	19148	19148	19148
2	6752	4787	3970
3	797	2128	1581
4	459	1197	823
5	187	766	496
6	106	532	328
7	58	391	231
8	46	299	171
9	31	236	131
10	23	191	103
…	…	…	…

Total	27774	31019	27598

Note*:* Own elaboration.

If we consider the Lotka index for authors considered to be in the elite range, 68.94% of authors have low productivity. In terms of average productivity, 30.37% of authors fall within this range, and only 0.68% of authors are in the high productivity range. Therefore, the law of author productivity is confirmed in this case.

Table 10. Percentage of authors' productivity according to Lotka.

Lotka index (log10)	**Productivity**	**%authors**
0	Low	68.94
Between 0 and 1	Medium	30.37
Greater than 1	High	0.68

Note*:* Own elaboration.

Distribution of Review Authors According to Lotka's Law

If we analyse Lotka's Law in relation to reviews, we can see that, out of a total of 1,831 authors, 95.85% (1,755) publish a single review, with two publications per author accounting for 3.17% (58) and three reviews accounting for 0.82% (15). In the case of four reviews per author, 0.16% (3) authors are identified. The value of m in this case is again close to the adapted version, with a value of 4.49.

Table 11. Distribution of producers according to Lotka's law. Reviews.

		$A_n=A_1/n^2$	**$A_n=A_1/n^m$**	
Reviews	**Authors**	**Expected authors 1**	**Expected authors 2**	**Apparent publications**
1	1755	1755	1755	1755
2	58	439	78	116
3	15	195	13	45
4	3	110	3	12
Total	1831	2498	1849	1928

Note*:* Own elaboration.

In this case, 95.85% of authors are low productivity authors. Average productivity authors account for 4.15%. This index indicates that there are no elite authors in this type of production, given that the threshold of 1 is not exceeded.

Table 12. Porcentaje de productividad de autores según Lotka. Revisiones.

Lotka index (log10)	**Productivity**	**%Authors**
0	Low	95.85
Between 0 and 1	Medium	4.15
Greater than 1	High	0.00

Note*:* Own elaboration.

Distribution of Proceedings Authors According to Lotka's Law

Of a total of 932 authors who publish proceedings, they preliminarily comply with Lotka's Law, given that 93.86% of authors publish only one conference proceedings. 5.14% publish two proceedings and 0.70% publish three. The rest accounts for 0.10% of authors with 4, 6, and 7 contributions to proceedings. The value of m in this case is closer to the calculated variant, whose value is 3.7.

Table 13. *Distribución de productores según Lotka. Actas.*

		$A_n=A_1/n^2$	**$A_n=A_1/n^m$**
Proceedings	**Authors**	**Expected authors 1**	**Expected authors 2**
1	932	932	932
2	51	233	72
3	7	104	16
4	1	58	6
6	1	26	1
7	1	19	1
Total	993	1371.71	1027.16

Note*:* Own elaboration.

In the case of contributions to conferences in the form of proceedings, no 'productive elite' is identified. Instead, 93.86% of authors are identified as being at the low productivity level with only one publication. 6.04% are at the medium productivity level with between 3 and 7 publications in conference proceedings.

Table 14. Percentage of authors' productivity according to Lotka. Proceedings.

Lotka index (log10)	Productivity	%Authors
0	Low	93.86
Between 0 and 1	Medium	6.04
Greater than 1	High	0.00

Note*:* Own elaboration.

Distribution of Book Chapter Production According to Lotka.

In the book chapters category, the sample is insufficient to draw any meaningful conclusions. However, it can be said that, of the total number of chapters registered in SCOPUS, the application of the Law is close to the data collected. With the caution that this should entail given the limitations, 84% of authors have published a single book chapter, and 16% have participated in three chapters. With regard to Lotka's index, for obvious reasons, there is an absence of a productive elite and the other levels identified by Lotka.

ANALYSIS

75.89% of production is concentrated in the last four years (2021-2024), which, despite its recent boom, means that the subject is still in its early stages. In terms of document type, articles account for more than 87% of all records indexed in SCOPUS. Reviews represent 4.93%, conference proceedings 2.90% and book chapters barely 0.10%, showing a marginal presence.

If we focus the analysis on geographical distribution, the United States leads scientific production, followed by China and England, which highlights the strategic and geopolitical-educational interest of the subject in the major powers. English continues to be the predominant language, although Spanish ranks second in articles and reviews. Given that Spanish quality agencies do not penalise publications in Spanish, it would be pertinent to analyse whether this policy has influenced this presence.

More than half of the publications analysed are available in Open Access Gold, which promotes immediate dissemination and free access to scientific results, facilitating academic production and collaboration.

Publishing output is mainly concentrated in articles, which account for more than half of the records. Ten publishers account for 48.91% of total output, with Public Library of Science (PLOS) and Nature Research standing out with 11.38% and 12.41% respectively. Some 1.42% of articles have no publisher record, indicating a small number of independent publications.

In reviews (5.17% of the total), MDPI leads with 14.13% of production, showing a focus on synthetic studies and systematic reviews. In conference proceedings (3.04%), the International Society for Photogrammetry and Remote Sensing (ISPRS) accounts for 72.18% of its category, reflecting a highly centralised conference space. The production of chapters (0.10%) is limited to two publishers, suggesting little editorial interest in this format.

"Editorial neglect" is observed in 1.54% of articles and 0.21% of proceedings, which could indicate gaps in traceability or editorial quality control. With regard to funding, almost 100% of the records lack declared support. Only 0.03% (three conference proceedings) report explicit funding. This suggests that production is mostly autonomous or without declaration of funds, which limits transparency and scientific traceability. However, institutional affiliation is present in 91.56% of articles and in 100% of other types, reinforcing the institutionalisation of knowledge, albeit without specific funding.

Among the ten most cited records, the main article does not strictly belong to the field of education, which could reflect a lack of specific output in education or inadequate labelling (keywords, title or abstract) affecting the accuracy of searches. In contrast, the most cited review does focus on education and AI, highlighting its guiding role in this emerging field, which is still in its early stages (Price). The proceedings show low citation rates and a predominance of technical editorials. The chapters have an anecdotal number of citations, highlighting their current limited scope.

Analysis of the scientific dispersion law (Bradford, 1985) shows that, in articles, specialisation is achieved in all three zones, although 99.65% of journals remain outside the core, which shows a significant dispersion of knowledge. In reviews, a single journal per area concentrates the majority of publications, leaving 98% of journals outside the core. In proceedings, records are concentrated in areas 1 and 3, with a predominance of low-specialisation publications (92.31%). In book chapters, 66.67% correspond to low-specialisation journals, although the sample is limited.

Finally, the Law of Author Productivity (Lotka) is fulfilled in the articles: 68.94% of authors have a single publication, while 0.68% have up to 85 articles, doubling the expected proportion of high specialisation. In reviews, 95.85% of authors produce a single publication, with 4.15% of medium specialisation and no elite producers. In proceedings, 93.86% have a single publication and 6.04% have medium productivity, with no highly specialised authors. The sample of chapters is insufficient to draw conclusions.

In all cases, the progression of m fits the adapted logarithmic function better, confirming the consistency between the authors observed and those expected according to the theoretical prediction of the law.

DISCUSSION

It appears that scientific articles are the predominant category of indexing in the study database, although registered reviews are also increasing significantly, from 0.22% in 2010 to 28.14% in 2024 in the categories indicated. Although this is not an exponential trend, it does indicate growing interest in the subject of education and AI in the records indexed in SCOPUS up to 2024.

This interest is global and supported by the current need for ethical use of AI and teacher training in technology. Following the Beijing Consensus (UNESCO, 2019) and the EU's Digital Education Action Plan included in its 2021-2027 agenda (education.ec.europa.eu). Europe has materialised its concern in the regulation of AI, crystallising it in its ethical guidelines for use (European Union [EU], 2022), taking into account that it is considered a high-risk tool if applied in education and vocational training (Madiega, 2024), which indicates a concern for AI and its inclusion in European education policies.

The aim of this study has been to conduct a preliminary scientometric analysis of the relationship between AI and education in order to obtain sufficient data to redirect necessary research efforts by identifying trends in the field of study.

After achieving the specific objectives and analysing the results obtained, it can be concluded that scientific production on the subject is in its early stages in all the categories analysed, with particular emphasis on the need to increase the sample size in the chapter category, since the records are anecdotal and it is not feasible to draw reliable conclusions from the data obtained so far. On the other hand, it can be said that production is concentrated in the United States and China as the main countries producing science on the subject in question, with the necessary constructive criticism of broadening perspectives and healthy competition if publications were to expand geographically, in a more equitable manner. On the other hand, the linguistic analysis brings back the eternal debate about the standard language in scientific publication: the language of publication continues to be English. However, the registration of other languages such as Spanish in second place for all categories is noteworthy. However, university accreditation policies seem to be promoting publication in other languages (National Agency for Quality Assessment and Accreditation [ANECA], 2024), so in the future, a comparison would be needed to determine whether the commitment to publish in languages other than English continues this trendIn addition, more than half of the output complies with the Gold category of Open Access. This may be related to the strong commitment to open science being promoted by governments and international academic institutions through https://www.crue.org/proyecto/acuerdos-con-editoriales, which is also being considered as a future line of research for comparative analysis. On the other hand, and as constructive criticism, it is argued that the centralisation of records in prestigious publishers with APC (author-paid publication charges) suggests that the drive to disseminate findings should be concentrated in these publishers. Another significant finding is that most scientific publishing continues to be joint, without specific funding and with authors affiliated with educational entities or institutions (91.56%).

On the other hand, analysis of the data on citations of articles, reviews, proceedings and chapters shows that the percentage of citations of the 10 most cited articles is significantly lower than that of reviews or proceedings, whose citation records exceed 30% for each category. From this, it could be inferred that the trend among scientific producers is to focus on synthetic bibliographies. We reiterate as a limitation of the section in question, and therefore of the study, the small sample size for the chapter category, which cannot detect a trend due to its scarcity. Furthermore, compliance with Bradford's law can be observed, with most publications appearing in journals with a low degree of specialisation. Similarly, Lotka's law of author productivity is also observed, with very few authors specialising in each category. In both cases, the chapter category remains the exception that limits the study due to the lack of a sufficient sample for analysis.

The results suggest that it would be advisable to increase production in conferences and book chapters, given their low representation, as well as to diversify the languages of publication to incorporate perspectives other than those of the main producing countries, whose approaches currently dominate research. The analysis of citations reveals inconsistencies in search terms, as the most cited article does not belong to the field of education, unlike the rest of the categories. This highlights the need to improve the selection of keywords and the structuring of

abstracts in order to optimise Boolean searches and obtain more accurate results that are more closely aligned with the subject matter.

A preliminary scientometric analysis is valuable for researchers, as it allows them to identify publication patterns, thematic trends and editorial policies, as well as to recognise possible scientific production elites and guide new lines of research. Finally, this study is the first scientometric analysis to link education with artificial intelligence in the SCOPUS database, adding value by highlighting trends and limitations in the field. These results lay the groundwork for future research and data-driven decisions on the intersection between AI and education.

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