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CHARTING THE DECADAL TRAJECTORY OF EDUCATIONAL RESEARCH: GROWTH FORECASTING, AUTHOR PRODUCTIVITY, AND NETWORK STRUCTURES

Dr. Mary Kamolina Ekka
Lecturer in Education
College of Teacher Education (CTE) Balangir, Odisha
Email id-marryekka2026@gmail.com

Abstract

This scientometric study analyzes the development trends and the present situation of the educational sciences discipline through the prism of peer-reviewed English-language papers in the Scopus database for the period 2016-2025 by the PRISMA-based selection criterion. A total of 7,262 papers have been published in 2,745 scientific journals at the average growth rate of 10.01% (Compound Annual Growth Rate) from 450 papers in 2016 to 1,196 in 2024. The highest citation rates were observed in 2018 (20,838 citations) and 2020 (20,526 citations). The life cycle evaluation using a logistic growth curve (R2=0.912) demonstrated that now only 10.0% of the potential saturation level of the discipline has been reached (K=72,620 papers) and implies the maximum annual output of 2,486 papers in 2038.8. The analysis of Bradford's Law indicated that the core nucleus included 121 (4.4%) journals providing 33.4% of the total number of papers; however, there were serious deviations from the classical model since the long-tailed periphery consisted of 2,036 journals. The author productivity strictly followed the modified Lotka's Law (β=2.8252, p=0.155) with 89.00% of authors having. Co-authorship network mapping demonstrated high localized team cohesion led by central hubs such as Liu Y, Wang Y, and Chen X, alongside isolated clinical clusters. These findings offer critical benchmarks for collection management, institutional policy, and international research collaboration.

Keywords: Educational Research; Bradford's Law; Lotka's Law; Logistic Growth Model; Co-Authorship Network; Scopus.

1. INTRODUCTION

Quantitative literature mapping, scientometrics and systematic synthesis have been developing as methods used to study the dynamics of evolution in academic institutions, pedagogical and curriculum-related aspects in educational research. In times of fast digitalization, pandemics, and increased accountability in education systems around the world, systematic and bibliometric mapping become a very useful method of empirical investigation of the dynamics of knowledge frontiers, citation networks, and institutional productivity.

The major topics in the field include institutional policy, national-level evaluation and research competitiveness. Transition economies use evaluation schemes aimed at creating conditions for outstanding performance of institutions. For example, Vîiu et al. (2016) conducted an empirical investigation of the research-oriented university classification and ranking policies of Romania, examining the influence of mandatory metrics by the state upon the institution hierarchy. Moreover, Narbaev et al. (2025) conducted decades' long bibliometric review of national higher education programs in Kazakhstan, paying attention to international research collaboration. Scientometric studies have been investigating institutional productivity, collaboration and citation dynamics based on long-term assessment of Indian Institutes of Science Education and Research (Solanki et al., 2016; Sahoo & Mohanty, 2021). Parallel research explores the relationship between the strategic mission of universities and global demands concerning the implementation of the United Nations Sustainable Development Goals in educational institutions and research centers (Bautista-Puig et al., 2021) and national frameworks for evaluation of postgraduate qualifications (Brasil, 2023).

On the other hand, educational research examines the rapid growth of digital technologies and automation in the context of learning. In order to introduce a system of governance regarding the issue of artificial intelligence development, the authors of Alduais et al. (2025) have created the "ETHICAL" protocol that should be utilized when adopting generative AI tools for academic research in higher education. Additionally, the development of artificial intelligence is discussed in the context of basic education – artificial intelligence in early childhood education is studied in Latorre-Medina & Abdelmaula-Mesaoud (2025). Finally, the development of digital and remote education is exemplified by the 43-year scientometric analysis of leadership in online education (Karimi & Saha, 2025) and multidecade review of open education scholarship (Shettar & Hadagali, 2022) and interactive classroom engagement trends (Shoaib et al., 2021).

Professional and specialized learning settings also represent an interesting area of study. Domain-specific research topics include new curricula in computer science education (Apiola et al., 2022), learning locations in engineering for K-12 students (Jin et al., 2024), and the expansion across the country of the "New Engineering Education" initiative in China (Shi, 2025). Concerning health sciences and clinical education, bibliometric studies focus on the use of portfolio assessment in medical education (Flores-Cohaila & Bustamante-Ordoñez, 2024), new curricula in health informatics (Han, 2024), and growth in publications in the Indian Journal of Pharmaceutical Education and Research (Pathak, 2020).

Additionally, researchers analyze the concept of equity, emergency response, and overall well-being of learners. Through longitudinal research, the decades-long history of social support programs within academic institutions is charted (Rashid et al., 2021), and 25 years of development of inclusive education models in China are explored (Wu, 2025). Responses of institutions to disrupting events are studied through global mapping of educational measures during emergencies caused by the outbreak of the coronavirus (Durrani & Ozawa, 2024; Karakose et al., 2021). In addition, equity-related research analyzes the history of gender representations within engineering education literature (Pawley et al., 2016), comparative frontiers of physical education pedagogy (Kuang et al., 2024; Saltan et al., 2025), and the history of vocational education (Tian et al., 2023). The current education research integrates macro-level scientometrics and detailed curricular evaluation.

2. REVIEW OF LITERATURE

The framework called ETHICAL is created by Alduais et al. (2025) for the responsible and controlled implementation of generative AI technologies in scientific research and education in higher education institutions. Expanding the scope of technologies to early development stages, Latorre-Medina and Abdelmaula-Mesaoud (2025) study the possibility of applying artificial intelligence in early childhood education research. Switching the focus from technological innovations to changes in organizations, Narbaev et al. (2025) conduct a literature and scientometric analysis of ten years of systemic modernization of higher education and science projects in Kazakhstan. In technical education, the historical background, paradigms, and trends that influence "New Engineering Education" projects in China are examined by Shi (2025), while Karimi and Saha (2025) present the results of a 43-year longitudinal scientometric analysis of leadership paradigms and administration changes in online education.

Pedagogical evaluation within the domain and curriculum-based evaluation demonstrate specialized knowledge related to educational training. In clinical education, the scientific literature about the application of portfolio assessment in the context of medical education is evaluated by Flores-Cohaila and Bustamante-Ordoñez (2024) as being effective in terms of experiential learning and competency assessment. In foundational training, Jin et al. (2024) use CiteSpace for revealing hotspots and development trends in K-12 engineering education. Besides, Wu (2025) provides a scientometric review for 25 years (1999-2024) concerning the development of inclusive education and educational equity in China. In crises management, Durrani and Ozawa (2024) systematically evaluate the global situation in the context of emergency education in the disruption due to the outbreak of the COVID-19 pandemic. Moreover, Kuang et al. (2024) visualize the state-of-the-art of physical education teaching in China and the United States in the context of enhanced genetic algorithms. On the other hand, Han (2024) evaluates the main topics and informatics curricula and networks in health informatics education.

Also, the evolution of technical, professional and open learning systems serves as an important part of educational research. Tian et al. (2023) use visual scientometric mapping in order to give an overview of the world literature on vocational education and training for the years 2004-2020. At the national level, Brasil (2023) reevaluates the classification and quality assessment systems for research and graduate programs in Brazil. Concerning pedagogical democratization, Shettar and Hadagali (2022) discuss the issue through scientometrics of open education research, while Apiola et al. (2022) employ the scientometric mapping of computing education research based on such components as keyword clusters, building blocks, creators and distribution channels. The problem of students' well-being is analyzed in 43-year-long (1977-2020) study by Rashid et al. (2021), and Shoaib et al. (2021) visualize publication patterns after 2000 concerning classroom participation, active learning and student engagement in higher education.

The final set of peer-reviewed articles concerns national research performance, scientometric benchmarking, and multidisciplinary research. First, Sahoo and Mohanty (2021) evaluate the research productivity and citation impact of the Indian Institutes of Science Education and Research (IISERs) using as their basis the previous research of Solanki et al. (2016) related to research competitiveness of the same institutions. In terms of regional research performance, Sych et al. (2020) provide a review of the studies of Ukrainian educational management that have been indexed in Scopus and Web of Science. Concerning the growth of research due to the pandemic of the COVID-19, the article of Karakose et al. (2021) analyzes the dynamics of the research in the field of medical education. The integration of sustainability in the research agenda is the topic of Bautista-Puig et al. (2021), who map the inclusion of UN SDGs in mission statements of universities and research institutions. In terms of disciplinary boundaries, Lund et al. (2020) empirically demonstrate the broad usage of social sciences and humanities research in educational studies. At the same time, Jiménez-Bucarey et al. (2020) apply the corporate branding concept in the field of education using bibliometric mapping.

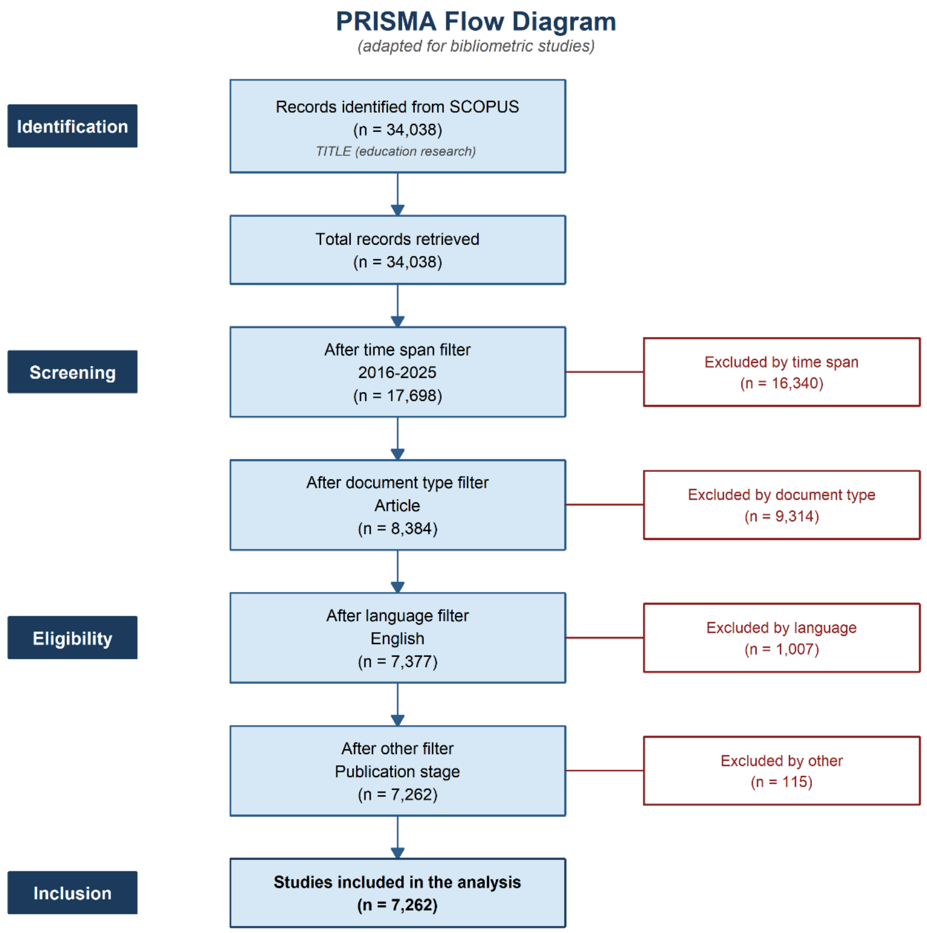
Lastly, disciplinary and sociological analyses provide examples of specialized fields of education and workforce patterns throughout history. The scientometric analysis by Pathak (2020) focuses on the Indian Journal of Pharmaceutical Education and Research. The institutional preferences across nations are examined in an article by Liu et al. (2019), which analyzes broad research topics in the literature of international higher education. Sociological and equity perspectives are presented in an article by Pawley et al. (2016), which presents the content analysis of gender issues in the Journal of Engineering Education (1998-2012), while the environmental education literature related to amphibians is analyzed in an article by Mormul et al. (2017). Concluding the policy domain, the empirical analysis by Vîiu and Miroiu (2016) presents a policy of research-based university ranking in Romania.

3. RESEARCH QUESTIONS

1. **RQ1:** What are the annual publication and citation growth patterns in educational research (2016–2025), and how does the life cycle model project its future trajectory?
2. **RQ2:** To what extent does the distribution of articles across journals conform to Bradford's Law of Scattering?
3. **RQ3:** How closely does author scientific productivity align with the theoretical and fitted formulations of Lotka's Law?
4. **RQ4:** What are the structural patterns and key collaborative clusters characterizing the co-authorship network in this field?

4. METHODOLOGY

For this bibliometric study with quantitative approach, trends of the education studies discipline have been investigated according to the metadata retrieved from Scopus on September 8, 2026. The screening strategy used the adapted version of the PRISMA selection procedure where only original articles in English written in 2016-2025 years with finalized publishing status were chosen. Consequently, there were 7,262 articles which have become the object of further analysis. Metadata processing, descriptive statistics, and publication growth distribution were conducted in Microsoft Excel 2016. Moreover, scientometric analysis was conducted with the help of the bibliometrix package of RStudio as mentioned in the Fig.1.

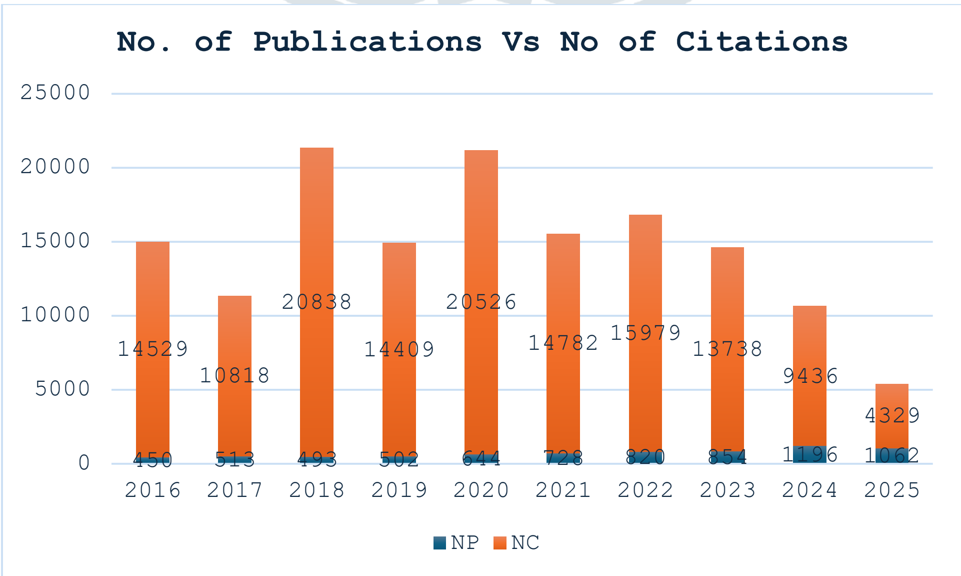


(Figure:1: prisma flow chart)

5. RESULTS

5.1 Annual Trends in Scientific Productivity and Citation Impact

As is shown on Graph-1, the trend of the development of scientific productivity (Number of Publications, NP) and citations (Number of Citations, NC) over 2016-2025 is evident. There is a growth of the quantity of scientific publications every year in the course of this period of time, since there were 450 publications in 2016, 1,196 in 2024, while 1,062 publications appeared in 2025. At the same time, there are peaks of citations in 2018 (20,838 citations) and 2020 (20,526 citations). The drop in the number of citations in 2023-2025 is explained by citation latency.



Graph-1: annual trends in scientific productivity and citation impact

5.2 Descriptive Profile of Publications

The descriptive metadata statistics for the corpus of educational research is illustrated in Figure-2 from the year 2016 to 2025. In the span of 10 years, 7,262 documents have been created in 2,745 different sources (journals) with an average yearly growth rate of 10.01%. The output of the academic corpus was made up of 21,507 authors, of which 1,518 authors produced single-authored documents, which shows that there are many collaborations in academics with an average number of 3.55 co-authors per document along with 18.14% of international co-authorship ratio. There were 16,059 unique author keywords (DE) supported by 302,184 cited references. Furthermore, the corpus has an average age of 4.6 years along with 19.19 average number of citations per document.

Figure-2: descriptive profile of publications

5.3 Scientific Production Life Cycle and Growth Forecast

Figure-3 depicts the life cycle and growth modeling prediction of the scientific production in educational research by using logistic growth model. This model has outstanding goodness of fit with R^2 of 0.912, RMSE of 72.03, AIC of 91.5 and BIC of 92.4. At the end of the observation period (2025), the domain reached total number of 7,262 publications (1,062 publications per year), which equals 10.0% of saturation capacity (K=72,620 publications).

Currently, during the fast growth phase (10-50% of saturation), the domain will keep growing for 32.1 years until it reaches inflection point and year of maximum growth in 2038.8 (approx. 2039), with maximum output per year equal to 2,486 publications. The long-term prediction from 2026-2093 years suggests accumulation of 16,768 publications in 2030 (output of 1,766 publications per year) and 27,102 publications in 2035 (output of 2,326 publications per year). It is expected that the research domain will reach state of 90% of saturation in 2054.8 and full maturity (99% of K) in 2072.3.

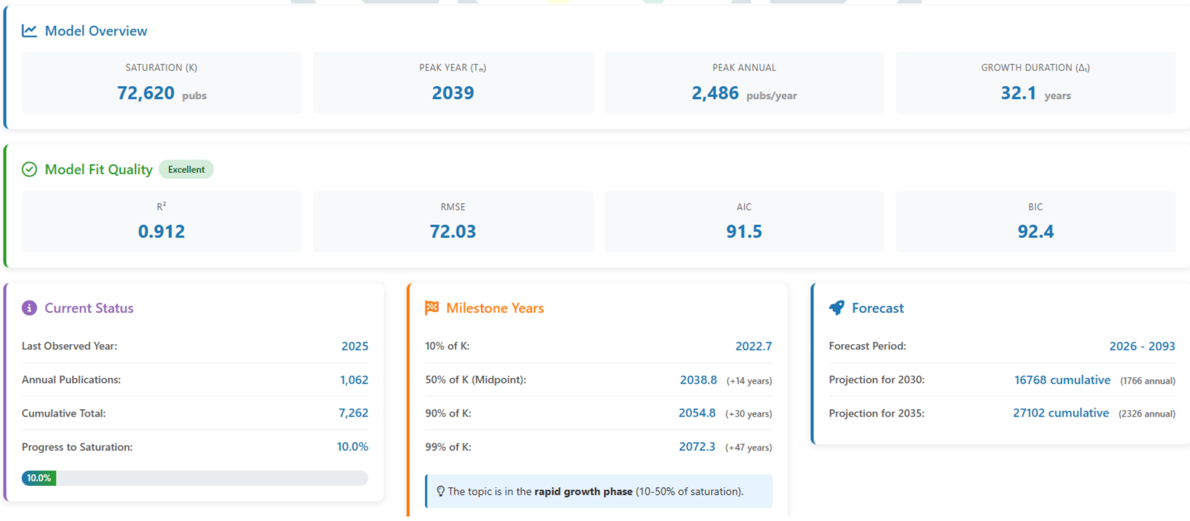
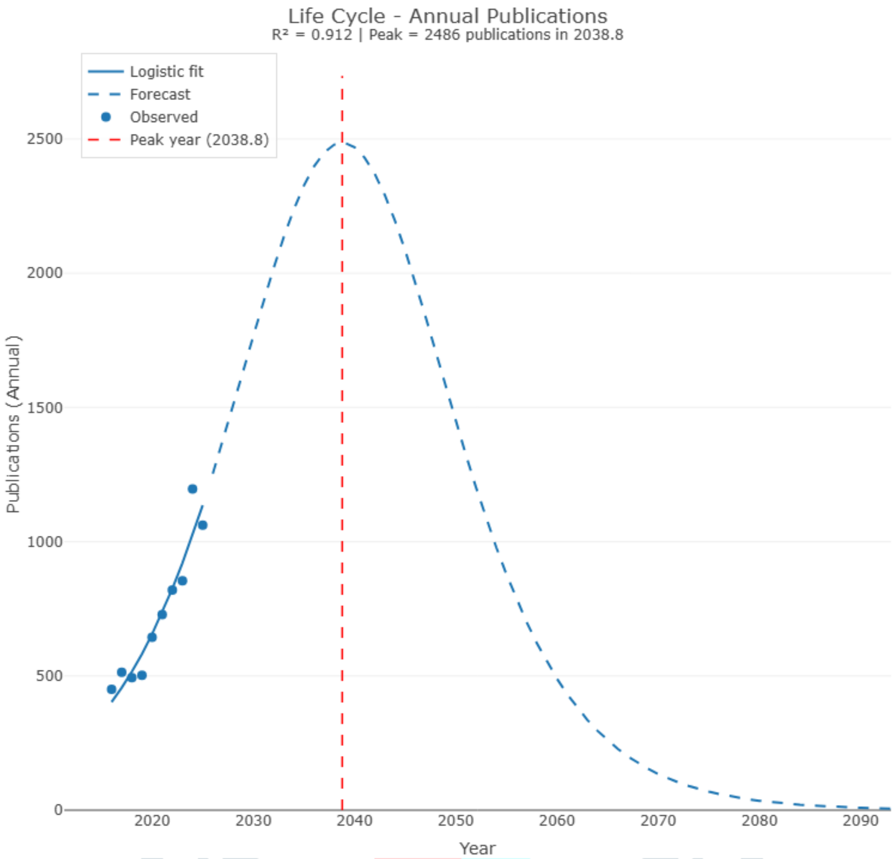


Figure-3: scientific production life cycle and growth forecast

5.4 Publication Life Cycle and Future Growth Projection

Graph-2 depicts the annual life cycle of the publication process as well as the forecast of the future of the research on education where the sigmoidal derivative of the logistic growth model is employed (R^2=0.912). Annual observations (Observed) from 2016 to 2025 show good correlation with the beginning of the ascending phase of the logistic growth model. The forecast (dashed blue line) shows that the annual increase will continue for the next ten years until the peak year of 2038.8 is reached where the annual production will be 2,486 articles. After that, a gradual decline in annual production will occur because the field will become saturated by 2090.

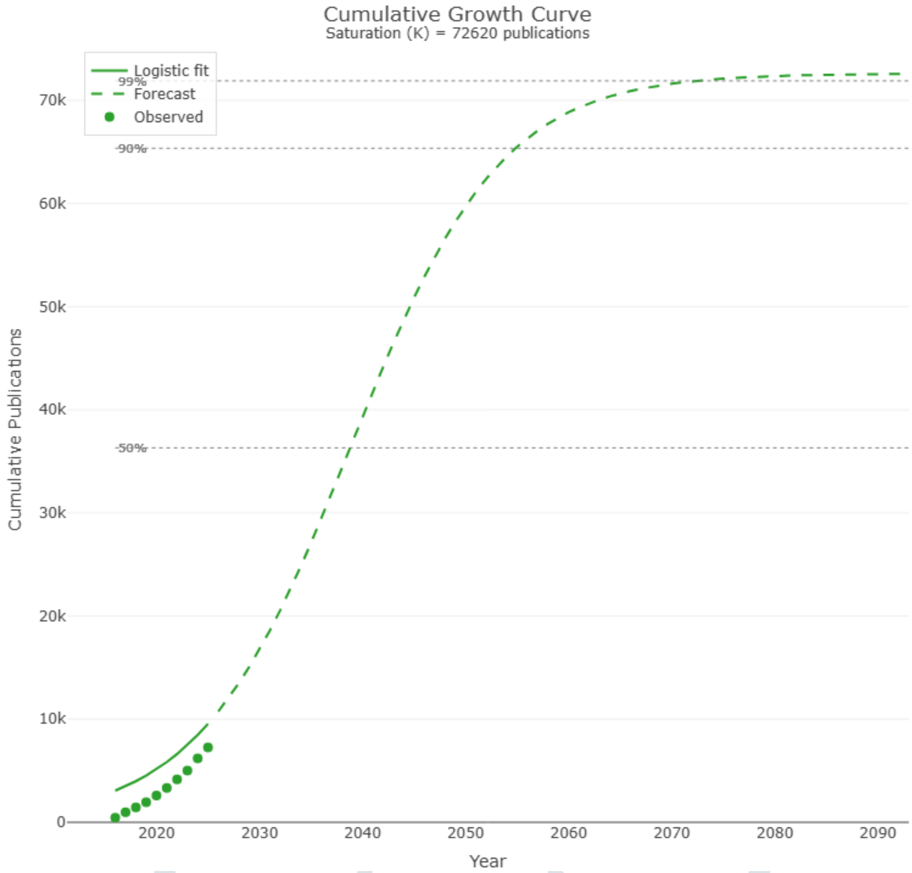


Graph-2: publication life cycle and future growth projection

5.5 Cumulative Publication Growth and Logistic Forecast

Graph-3 depicts the growth curve of the number of scientific papers published on the topic of educational research based on the classical S-shaped logistic growth model having an estimated saturated level of K=72,620 papers. The actual data points (green dots) in the range from 2016 to 2025 reflect the takeoff stage of the field's development and fit perfectly well into the logistic curve (solid line).

The future growth curve (dashed green line) forecasts a quick accumulation period in the coming decades, achieving the 50% halfway stage (~36,310 papers) approximately by 2039. The speed of the accumulation slows down at the 90% level (~65,358 papers), achieved in the mid of 2050s and ultimately achieves the saturated stage (when the accumulation approaches 99%) (~71,894 papers) in the 2070s. It can be seen that despite the fact that the field is currently in the matured stage of development, there is still much room left for further expansion.



Graph-3: cumulative publication growth and logistic forecast

5.6 Bradford's Law of Scattering and Source Distribution

Bradford's Law of Scattering was analyzed in order to determine the extent of literature concentration and scattering among the 2,745 source journals utilized in the corpus. Consistent with Bradford's method, the literature was grouped into three sets of zones, where each zone contains roughly one third (33.3%) of the total number of 7,262 publications as follows:Zone 1 (Core sources): This zone contains 121 journals (4.4% of total sources) which contain 2,428 publications (33.4%).This indicates high concentration of the specialized medium for scholarly communications in which most educational research is carried out. Zone 2 (Moderately productive sources): Contains 588 journals (21.4% of total sources) publishing 2,414 publications (33.2%).These are the publications from the secondary and allied disciplines. _zone 3 (Peripheral sources): Contains 2,036 sources (74.2% of total sources) publishing 2,420 publications (33.3%).These are the extensive peripheral literature sources common to interdisciplinary areas like the social sciences. The cumulative number of articles C(r) as a function of the logarithm of the rank of sources log(r) can be written using linear regression:

$$C(r) = -4155.5988 + 1397.5966 \cdot \log(r)$$

The model demonstrates strong linear conformity in the non-core regions with a coefficient of determination of $R^2 = 0.9693$. The empirical Bradford multiplier (k) was determined to be 4.16, reflecting the expected geometric expansion across successive zones ($121\colon 588\colon 2036 \approx 1\colon k\colon k^{1.97}$).

To evaluate theoretical compliance, a Kolmogorov-Smirnov (KS) goodness-of-fit test was conducted against the null hypothesis (H_0) that the empirical data strictly adheres to the theoretical Bradford distribution. The test yielded a test statistic of $D = 0.1286$ with an associated p-value $< 2 \times 10^{-16}$. Because $p < 0.05$, the null hypothesis is rejected, demonstrating that while the literature exhibits strong Bradfordian clustering, the empirical distribution deviates significantly from the idealized theoretical model due to an extended peripheral tail of single-article journals.

Zone	N. Sources	% Sources	N. Articles	% Articles
Zone 1	121	4.4%	2428	33.4%
Zone 2	588	21.4%	2414	33.2%
Zone 3	2036	74.2%	2420	33.3%
Total	2745	100%	7262	100%

5.7 Author Productivity through Lotka's Law

Lotka's Law was applied to examine author productivity and test the degree of specialization among researchers in the field. The inverse power law models the proportion of authors $f(n)$ publishing exactly n articles as:

$$f(n) = \frac{C}{n^{\beta}}$$

where C is a constant and β represents the characteristic exponent determining the rate of decay in author output.

As summarized in Table 1, the empirical author distribution reveals an overwhelming concentration of transient contributors. Out of the total author population, 19,143 authors (89.00%) contributed only a single document. Authors producing two documents accounted for 1,610 individuals (7.49%), while 407 authors (1.89%) published three documents. A progressive reduction is observed for higher productivity tiers: 138 authors (0.64%) published four documents, 75 authors (0.35%) published five documents, and only 135 authors (0.62%) produced more than five papers.

5.8 Model Fitting and Goodness-of-Fit Testing

The estimated parameters of the empirical distribution yielded an exponent $\beta = 2.8252$, a constant $C = 0.3467$, and a coefficient of determination of $R^2 = 0.9346$. To assess the validity of Lotka's formulation, Kolmogorov-Smirnov (KS) goodness-of-fit tests were performed under two conditions:Test 1: Empirical vs. Classical Theoretical Model ($\beta = 2.0000$):Testing against the generalized classical value of $\beta = 2.0$ resulted in a KS statistic of $D = 0.68$ with an associated p-value of 1.91×10^{-5}. Because $p < 0.05$, the null hypothesis (H_0) is rejected, confirming that the empirical data deviates significantly from classical theoretical Lotka's Law. The higher empirical exponent ($\beta \approx 2.83$) indicates a steeper drop-off in multi-authored production compared to classical expectations, driven by an unusually high proportion of one-time authors (89.0% vs. the theoretical ~60.8%).

Test 2: Empirical vs. Fitted Model ($\beta = 2.8252$): Evaluating the empirical distribution against the specifically estimated parameter ($\beta = 2.83$) produced a KS statistic of $D = 0.32$ and a p-value of 0.155. Because $p \geq 0.05$, the null hypothesis cannot be rejected.

5.9 Collaboration Network of authors

Figure-3 illustrates the co-authorship network of prolific authors in the field of education research where nodes are indicative of publication frequency, edges are indicative of co-authorship, and colors are indicative of collaborative groups. In this co-authorship network, there is a blue group which is dominated by the large node of Liu Y. Other members of this group include Chen J and Wang X. Central red group includes Wang Y and Li Y. In addition to these, there are other collaborative groups such as the green group which includes Chen X and Li J, purple group including Zhang Y and Li X, and orange group including Wang J and Li Z.

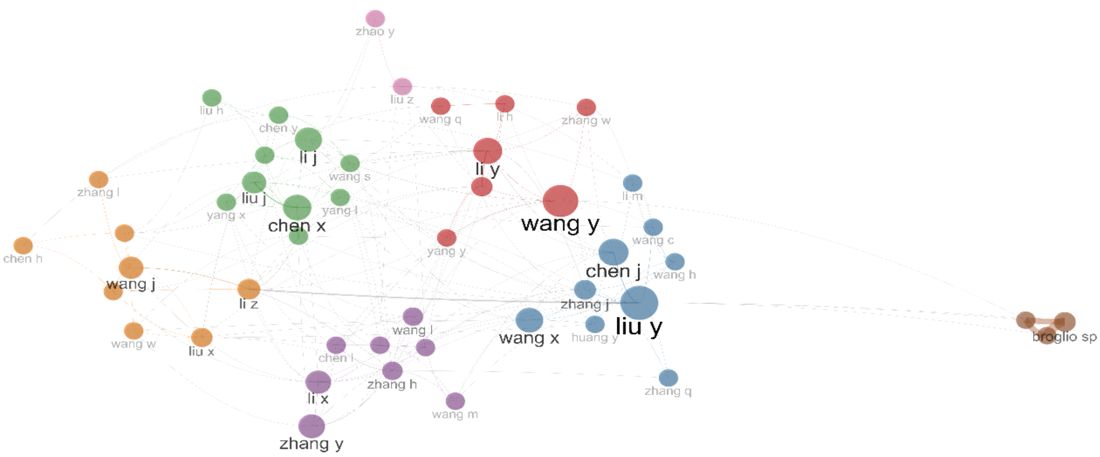


Figure-3: collaboration network of authors

6. DISCUSSION

The findings gathered through this bibliometric study for the last 10 years indicate the progress, extent, and collaboration trends of educational research studies conducted during 2016 – 2025 years. There has been steady progress in terms of the number of publications every year, at Compound Annual Growth Rate of 10.01%, rising from 450 publications in 2016 to 1,196 publications in 2024. At the same time, there has been a peak in the number of citations in 2018 (20,838 citations) and 2020 (20,526 citations).

Mathematical growth modeling captures the dynamics associated with the field. The fit logistic growth model ($R^2 = 0.912$) illustrates that the subject matter continues to grow very fast (10–50% saturation level), but has reached only 10.0% of its saturation level (K=72,620). The inflection point is projected to be reached by 2038.8, while the maximum annual publication will be 2,486.

The analysis according to Bradford's Law proved that there was the high concentration in the publishing process and the large dispersion in the multidisciplinary aspect. Core of 121 publications (4.4%) accounted for 33% of all publications (n=2,428). However, there were significant deviations from the classical theoretical distribution distributions ($p < 2 \times 10^{-16}$), owing to the wide periphery of 2,036 publications (74.2%), that indicated at the high thematical dispersion in specialized and regional journals. The productivity of authors considerably correlated with the modified version of Lotka's Law (β=2.8252,p=0.155), since 89% of scientists published only one article. Consequently, the core science is led by the small elite group of scientists along with occasional scientists. Network analysis not only revealed the clusters of collaboration of famous scientists (Liu Y, Wang Y, Chen X), but also peripheral isolated clusters (Broglio SP). There should be more international collaboration in addition to the current one of 18.14%.

7. CONCLUSION

The present study constitutes a comprehensive scientometric analysis of the educational science literature published worldwide within the framework of Scopus database during the years 2016-2025. With the help of quantitative bibliometrics, growth models, and network analysis, it was shown that the education science domain is characterized by substantial decadal growth, fueled by high rates of multi-authorship (3.55 authors per document) and high-level interdisciplinarity, reflected in dissemination of knowledge into 2,745 documents. The validity of the logistic growth model confirmed that the considered field reached just one tenth of its saturation limit.

Implications of the results are threefold. First, for journal editors and librarians in an academic sphere, the identification of 121 core papers using Bradford's law allows for the development of an evidence-based approach to collection management and distribution of subscriptions, as well as manuscripts' indexing. Second, for schools and sponsors of researches, the skewed distribution, according to Lotka, reveals the need to develop sustainable funding programs for young scientists in order to bridge the gap between single-paper writers and research programs. Third, for international research collaborations, the co-authorship pattern reveals the necessity to switch from local to international co-authorship groups capable of tackling global education issues, such as AI ethics and emergency education.

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