Volume-01
Issue-07
July-2026

ISSN: 2663-0931
International Journal of
Interdisciplinary Current Advanced Research
www.ijicar.in

Mapping the Research Landscape of Artificial Intelligence in Mathematics: A Bibliometric Study

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ARTICLE DETAILS

Article History

Received Date:10-06-2026

Revised Date: 30-06-2026

Accepted Date: 02-07-2026
Published Online: 06-07-2026

Keywords
Artificial Intelligence, Mathematics, Mathematics Education, Bibliometric Analysis, Scopus, Knowledge Mapping, ChatGPT.

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ABSTRACT

Artificial Intelligence (AI) has emerged as one of the most transformative technologies of the twenty-first century, significantly influencing scientific research, education, and mathematical problem-solving. Recent advances in machine learning, deep learning, intelligent tutoring systems, and generative AI have accelerated the integration of AI into mathematics research and mathematics education, resulting in a rapidly expanding body of scholarly literature. Despite this growth, a comprehensive understanding of the intellectual structure, publication trends, influential contributors, and emerging research themes remains limited. This study addresses this gap through a bibliometric analysis of global research on artificial intelligence in mathematics. Bibliographic records were retrieved from the Scopus database, yielding 497 publications indexed between 1993 and 2026. Descriptive bibliometric techniques were employed to examine publication growth, citation performance, prolific authors, productive institutions, leading journals, contributing countries, funding agencies, and frequently occurring keywords. The findings reveal a remarkable increase in research output after 2020, coinciding with the rapid adoption of generative AI technologies. The United States and China emerged as the leading contributors, while Annals of Mathematics and Artificial Intelligence was identified as the most productive publication outlet. Keyword analysis highlights a strong emphasis on mathematics education, intelligent learning systems, engineering education, and ChatGPT, reflecting a shift toward AI-enabled teaching and learning. This study provides a comprehensive overview of the evolution of AI in mathematics and offers valuable insights for researchers, educators, policymakers, and funding agencies seeking to understand current developments and future research directions.

1. Introduction

Artificial Intelligence (AI) has emerged as one of the most transformative technologies of the twenty-first century, influencing scientific research, education, healthcare, engineering, and decision-making. Recent advances in machine learning, deep learning, and generative AI have significantly enhanced computational capabilities, enabling intelligent systems to perform complex analytical and reasoning tasks that traditionally required human expertise Russell & Norvig, (2021). These developments have accelerated the integration of AI into mathematics, where it supports mathematical modeling, optimization, theorem proving, symbolic computation, and data analysis.

Beyond mathematical research, AI has become increasingly important in mathematics education. Intelligent tutoring systems, adaptive learning platforms, automated assessment, and educational chatbots have transformed teaching and learning by providing personalized instruction, real-time feedback, and improved student engagement Luckin et al., (2016). More recently, the emergence of large language models such as ChatGPT has expanded opportunities for AI-assisted problem solving, mathematical reasoning, and interactive learning, while simultaneously raising concerns regarding accuracy, ethics, and academic integrity Kasneci et al., (2023).

The growing adoption of AI across mathematics research and education has resulted in a substantial increase in scientific publications. A landmark study by Davies et al. (2021) demonstrated the potential of AI to guide human intuition in solving complex mathematical problems, highlighting its role in

advancing mathematical discovery. Similarly, Hwang and Tu (2021) reported a rapid increase in research on AI in mathematics education, with major themes including intelligent tutoring systems, personalized learning, and learning analytics. These studies illustrate the expanding scope and interdisciplinary nature of AI applications in mathematics.

As scholarly output continues to grow, synthesizing the existing literature becomes increasingly challenging. Bibliometric analysis provides a systematic and quantitative approach for evaluating scientific productivity, citation impact, collaboration patterns, and thematic evolution within a research field Donthu et al., (2021). Unlike conventional literature reviews, bibliometric techniques enable researchers to identify influential publications, prolific authors, leading institutions, collaborative networks, and emerging research themes, thereby offering a comprehensive understanding of the development of scientific knowledge Aria & Cuccurullo, (2017).

Although several bibliometric studies have investigated AI in education, comparatively few have examined the broader research landscape of **artificial intelligence in mathematics**, encompassing mathematical research, mathematics education, scholarly productivity, citation impact, institutional contributions, funding patterns, and emerging research topics. Given the rapid expansion of AI technologies, particularly after the introduction of generative AI, an updated bibliometric assessment is necessary to understand how the field has evolved and to identify future research directions.

Therefore, this study presents a comprehensive bibliometric analysis of global research on artificial intelligence in mathematics using publications indexed in the Scopus database. Specifically, the study examines publication growth, citation performance, prolific authors, leading journals, productive institutions, contributing countries, funding agencies, highly cited publications, and frequently occurring keywords. The findings provide a comprehensive overview of the intellectual development of the field and offer valuable insights for researchers, educators, policymakers, and funding agencies interested in advancing AI applications in mathematics.

2. Literature review

Artificial intelligence (AI) has emerged as a transformative technology with applications across scientific research, engineering, healthcare, and education. Recent advances in machine learning, deep learning, and generative AI have expanded the use of intelligent systems for solving complex mathematical problems, supporting theorem discovery, automating symbolic computation, and enhancing educational practices Russell & Norvig (2021). Among these developments, large language models such as ChatGPT have accelerated interest in AI-assisted mathematical reasoning and personalized learning environments Kasneci et al., (2023).

Within mathematics, AI has contributed significantly to both research and education. In mathematical research, AI techniques have been employed for optimization, pattern recognition, numerical computation, and automated theorem proving. Davies et al. (2021) demonstrated the capability of AI to support mathematical discovery by identifying hidden structures and generating conjectures that assisted mathematicians in solving previously unsolved problems. This work marked a significant milestone by illustrating AI's potential to augment, rather than replace, human mathematical reasoning.

In mathematics education, AI has been widely adopted through intelligent tutoring systems, adaptive learning environments, automated assessment, educational chatbots, and learning analytics. These technologies facilitate personalized instruction, provide immediate feedback, and improve student engagement and learning outcomes Luckin et al., (2016). As a result, AI has become an increasingly important component of technology-enhanced mathematics education. The emergence of generative AI has further transformed mathematics education. Applications such as ChatGPT enable learners to generate mathematical explanations, solve problems, and receive interactive guidance in real time. Although these tools offer substantial educational opportunities, concerns regarding the accuracy,

reliability, and ethical use of AI-generated mathematical solutions continue to attract scholarly attention Kasneci et al., (2023). Consequently, research has increasingly focused on balancing the pedagogical benefits of AI with issues related to academic integrity and responsible AI use.

Bibliometric analysis has become an established methodology for evaluating scientific productivity and mapping the intellectual structure of research fields. Unlike traditional literature reviews, bibliometric techniques quantitatively examine publication trends, citation impact, collaboration networks, and thematic evolution, thereby providing a comprehensive understanding of knowledge development Donthu et al., (2021). The introduction of the **Bibliometrix** package by Aria and Cuccurullo (2017) further facilitated bibliometric research by providing accessible tools for science mapping and performance analysis.

Several bibliometric studies have investigated AI in education. Hwang and Tu (2021) analyzed research trends in artificial intelligence in mathematics education and reported a rapid increase in publications, with intelligent tutoring systems, adaptive learning, and personalized education emerging as dominant research themes. Similarly, recent reviews have highlighted the growing influence of generative AI and ChatGPT on educational research, particularly in teaching, assessment, and learner support Dwivedi et al., (2023).

Despite these contributions, existing bibliometric studies have primarily focused on AI in education or on specific AI technologies. Comparatively limited attention has been devoted to examining the broader research landscape of **artificial intelligence in mathematics**, encompassing mathematical research, mathematics education, scholarly productivity, citation impact, institutional contributions, funding patterns, and emerging research themes within a single comprehensive framework.

To address this gap, the present study employs bibliometric techniques to map the global research landscape of AI in mathematics. By analyzing publication trends, citation patterns, prolific authors, leading institutions, productive countries, funding agencies, influential publications, and research keywords, this study provides a comprehensive overview of the evolution of the field and identifies emerging directions for future research.

3. Methodology

This study employed a **bibliometric research design** to examine the global research landscape of artificial intelligence (AI) in mathematics. Bibliometric analysis is a quantitative approach used to evaluate scientific literature through publication, citation, and productivity indicators. The bibliographic data were retrieved exclusively from the **Scopus** database because of its comprehensive coverage of high-quality peer-reviewed literature and standardized indexing. The search was conducted using the keywords related to *Artificial Intelligence* and *Mathematics* in the **Title** field. All publications indexed up to **2026** were considered. After screening and removing irrelevant records, a total of **497 publications** constituted the final dataset.

The retrieved records were exported in CSV format and analyzed using descriptive bibliometric techniques. The analysis focused on publication trends, document types, citation performance, prolific authors, leading journals, productive institutions, contributing countries, funding agencies, and keyword frequencies. Descriptive statistics were computed using **Microsoft Excel**, while bibliometric indicators such as publication output, citation counts, average citations, collaboration index, and annual growth rate were used to characterize the research landscape.

The findings are presented through tables and graphical visualizations to provide a comprehensive overview of the evolution, productivity, and emerging research trends in AI applied to mathematics.

4. Research Objectives

Despite the growing body of literature on artificial intelligence in mathematics, a comprehensive understanding of its publication trends, scholarly contributions, citation impact, and emerging research

themes remains limited. Existing studies have primarily focused on specific educational applications or individual AI technologies, leaving the broader research landscape insufficiently explored. To address this gap, the present study aims to map the global research landscape of artificial intelligence in mathematics using bibliometric techniques. Specifically, the study seeks to:

1. Examine the publication growth and evolution of research on artificial intelligence in mathematics.
2. Analyze the bibliometric characteristics of the retrieved publications, including document types, citation performance, and collaboration patterns.
3. Identify the most productive authors, journals, institutions, countries, and funding agencies contributing to the field.
4. Determine the most influential publications shaping the intellectual development of artificial intelligence in mathematics.
5. Explore the dominant research themes through keyword frequency analysis and identify emerging trends in the field.
6. By accomplishing these objectives, the study provides a comprehensive overview of the development of artificial intelligence in mathematics and offers valuable insights into current research directions and future opportunities.

5. Analysis and Interpretation

Table 1: Publication Output by Document Type

Rank	Document Type	Publications	Percentage (%)
1	Article	222	44.67
2	Conference Paper	132	26.56
3	Book Chapter	54	10.87
4	Erratum	22	4.43
5	Editorial	19	3.82
6	Conference Review	17	3.42
7	Review	12	2.41
8	Note	9	1.81
9	Book	8	1.61
10	Retracted	1	0.20
11	Letter	1	0.20
Total	All Document Types	497	100.00

Table 1 illustrates the distribution of the 497 retrieved publications according to document type. Research articles constitute the dominant publication format, accounting for **222 publications (44.67%)**, followed by **conference papers (132; 26.56%)** and **book chapters (54; 10.87%)**. Together, these three categories represent more than **82%** of the total research output, indicating that scholarly communication in artificial intelligence (AI) and mathematics relies primarily on peer-reviewed journal articles while conferences remain an important platform for disseminating emerging findings.

The relatively high proportion of conference papers reflects the rapid pace of innovation in AI, where researchers frequently present preliminary findings before journal publication. Book chapters further indicate the interdisciplinary nature of the field, particularly in educational technology and computational mathematics.

Conversely, review articles account for only **2.41%** of the retrieved literature, suggesting that the field is still in an active growth phase characterized by the production of original research rather than extensive evidence synthesis. The presence of editorial materials, notes, errata, and conference reviews demonstrates the maturation of the discipline, while only one retracted publication indicates that issues relating to research integrity remain limited.

Table 2: General Characteristics of the Retrieved Publications

Indicator	Value
Total publications	497
Total Citations	3457
Study period	1990-2026
Total authors	1454
Total journals	286
Average citations per document	6.95
Average citations per year	150.30
Average authors per paper	2.93
Collaboration index	3.59

Table 2 summarizes the overall characteristics of the retrieved dataset. A total of **497 publications** produced between **1990 and 2026** accumulated **3,457 citations**, resulting in an average of **6.95 citations per publication**, which indicates a moderate citation impact for this emerging research domain.

The publications involved **1,454 authors**, corresponding to an average of approximately **2.93 authors per publication**, demonstrating that collaborative research has become the predominant mode of knowledge production in AI and mathematics. Furthermore, the **collaboration index of 3.59** suggests that multi-authored studies dominate the literature and reflects the interdisciplinary character of the field, requiring expertise from mathematics, computer science, artificial intelligence, educational technology, and learning sciences. The retrieved publications were distributed across **286 different journals**, indicating that AI in mathematics is not confined to a single discipline but is instead disseminated through a broad range of mathematics, computer science, education, engineering, and interdisciplinary journals. These findings indicate that AI in mathematics has evolved into an interdisciplinary research domain characterized by moderate citation impact, increasing scholarly collaboration, and broad dissemination across diverse academic outlets.

Table 3. Annual Publication Trend

Year	Publications	Growth Rate (%)	Year	Publications	Growth Rate (%)
1993	1	–	2014	1	-66.67
2000	1	0.00	2015	1	0.00
2002	4	300.00	2016	1	0.00
2003	3	-25.00	2017	2	100.00
2004	4	33.33	2018	4	100.00
2006	4	0.00	2019	3	-25.00
2007	3	-25.00	2020	7	133.33
2008	3	0.00	2021	15	114.29
2009	1	-66.67	2022	20	33.33
2010	3	200.00	2023	34	70.00
2012	1	-66.67	2024	73	114.71
2013	3	200.00	2025	171	134.25
			2026	134	-21.64

Table 3 demonstrates the temporal evolution of research on artificial intelligence in mathematics. The earliest publication appeared in **1993**, after which publication activity remained sporadic for nearly two decades. Between **1993 and 2019**, annual output rarely exceeded four publications, reflecting the infancy of AI applications within mathematical research and education.

A notable turning point occurred after **2020**, when publication output increased substantially. Annual publications rose from **7 in 2020** to **15 in 2021**, **20 in 2022**, **34 in 2023**, **73 in 2024**, and reached **171 publications in 2025**, representing the highest annual productivity during the study period.

The substantial increase after 2021 coincides with the rapid advancement of generative AI technologies, including large language models and intelligent tutoring systems, which have accelerated research on AI-assisted mathematics teaching, learning analytics, automated assessment, and mathematical reasoning. Although publications declined to **134 in 2026**, this decrease should be interpreted cautiously because the database was collected before the completion of the publication year.

The publication trend clearly demonstrates that AI in mathematics has transitioned from an emerging niche topic to a rapidly expanding global research area.

Table 4. Most Productive Authors

Rank	Author	Number of Publications	Total Citations	h-index	Country
1	Wijaya, T.T.	6	200	4	Austria
2	Li, C.	5	38	2	USA
3	Castelvecchi, D.	5	20	2	UK
4	Cao, Y.	5	165	4	China
5	Li, M.	4	70	3	China
6	Dix, J.	4	14	2	Germany
7	Boateng, F.O.	4	5	1	Ghana
8	Xing, W.	3	38	2	USA
9	Wijayanti, D.	3	1	1	Indonesia
10	Weinhandl, R.	3	62	1	Austria

Table 4 identifies the leading contributors to AI in mathematics research. **Wijaya T.T.** emerged as the most productive author with six publications, followed by **Li C.**, **Castelvecchi D.**, and **Cao Y.** with five publications each. However, publication productivity alone does not necessarily reflect scholarly influence. For example, **Cao Y.** accumulated considerably more citations than several authors with comparable publication counts, indicating greater research impact. Similarly, differences in h-index values suggest varying levels of sustained scholarly influence.

The relatively small publication counts among the leading authors indicate that the field remains highly distributed rather than being dominated by a few prolific researchers. The research landscape exhibits a decentralized authorship structure, suggesting opportunities for new scholars to establish influence within this rapidly expanding domain.

Table 5. Leading Journals

1.	Annals of Mathematics and Artificial Intelligence	31
2.	Lecture Notes in Networks and Systems	12
3.	AIP Conference Proceedings	10
4.	International Journal of Learning, Teaching and Educational Research	10
5.	Communications in Computer and Information Science	9
6.	The Convergence of Mathematics and AI: A New Paradigm in Education	9
7.	Education Sciences	7
8.	Nature	7
9.	ACM International Conference Proceeding Series	6
10.	Education and Information Technologies	6

The retrieved publications were published across numerous journals, reflecting the interdisciplinary nature of AI in mathematics. **Annals of Mathematics and Artificial Intelligence** emerged as the primary publication venue, followed by **Lecture Notes in Networks and Systems**, **AIP Conference Proceedings**, and several education-focused journals.

The diversity of publication outlets demonstrates that research spans mathematics, computer science, educational technology, and artificial intelligence. High-impact journals such as **Nature** indicate that AI-assisted mathematical discovery has attracted substantial attention beyond mathematics education. The dispersion of publications across mathematics, education, and AI journals illustrates the multidisciplinary development of the research field.

Table 6. Most Productive Institutions

Rank	Affiliation	Country	Publications
1	East China Normal University	China	8
2	Johannes Kepler University Linz	Austria	8
3	Beijing Normal University	China	8
4	Tecnológico de Monterrey	Mexico	6
5	University of Florida	United States	6
6	University of the Free State	South Africa	5
7	The University of Utah	United States	5
8	Universiti Sains Malaysia	Malaysia	4
9	University of South Africa	South Africa	4
10	Monash University	Australia	4

Three institutions **East China Normal University**, **Johannes Kepler University Linz**, and **Beijing Normal University**shared the highest publication output. Universities from China, the United States, South Africa, Australia, Malaysia, Austria, and Mexico collectively demonstrate broad institutional participation. The strong representation of Chinese universities reflects the country's significant investment in AI research and educational innovation. Institutional productivity highlights increasing international participation, with Asian universities playing particularly prominent roles.

Table 7. Leading Countries

Rank	Country	Publications
1	United States	70
2	China	69
3	Indonesia	25
4	India	25
5	South Africa	21
6	Philippines	20
7	United Kingdom	18
8	Turkey	18
9	Malaysia	14
10	Spain	13

The **United States (70 publications)** and **China (69 publications)** dominate global research output, jointly accounting for approximately **28%** of all retrieved publications. Indonesia and India each contributed **25 publications**, while South Africa and the Philippines also demonstrated substantial research activity. This distribution indicates that AI in mathematics has expanded beyond traditional research-intensive countries and now includes considerable contributions from emerging economies.

The geographic diversity demonstrates the global diffusion of AI technologies within mathematics research and education.

Table 8. Most Highly Cited Papers

Rank	Title	First Author	Source	Year	Citations
1	Advancing mathematics by guiding human intuition with AI	Davies, A.	Nature	2021	425
2	Roles and research trends of artificial intelligence in mathematics education: A bibliometric mapping analysis and systematic review	Hwang, G.-J.	Mathematics	2021	326
3	Developing an AI-based chatbot for practicing responsive teaching in mathematics	Lee, D.	Computers and Education	2022	185
4	Educing AI-thinking in science, technology, engineering, arts, and mathematics (STEAM) education	How, M.-L.	Education Sciences	2019	120
5	Artificial Intelligence in Education: Mathematics Teachers' Perspectives, Practices and Challenges	Wardat, Y.	Iraqi Journal for Computer Science and Mathematics	2024	110
6	Fostering AI Literacy in Elementary Science, Technology, Engineering, Art, and Mathematics (STEAM) Education in the Age of Generative AI	Relmasira, S.C.	Sustainability	2023	99
7	Artificial intelligence, computational thinking, and mathematics education	Gadanidis, G.	International Journal of Information and Learning Technology	2017	89
8	Modern Artificial Intelligence Model Development for Undergraduate Student Performance Prediction: An Investigation on Engineering Mathematics Courses	Deo, R.C.	IEEE Access	2020	71
9	Latent Profile Analysis of AI Literacy and Trust in Mathematics Teachers and Their Relations with AI Dependency and 21st-Century Skills	Wijaya, T.T.	Behavioral Sciences	2024	66
10	Examining Chinese Preservice Mathematics Teachers' Adoption of AI Chatbots for Learning: Unpacking Perspectives Through the UTAUT2 Model	Wijaya, T.T.	Education and Information Technologies	2025	Not yet available*

Citation analysis identifies the intellectual foundations of the field. The paper **"Advancing Mathematics by Guiding Human Intuition with AI"** published in *Nature* received **425 citations**, making it the most influential publication. Hwang and Tu's bibliometric review received **326 citations**, demonstrating the importance of research synthesis within AI-supported mathematics education.

Highly cited papers primarily focus on mathematical discovery, AI-assisted teaching, intelligent tutoring systems, ChatGPT, AI literacy, and computational thinking, indicating the evolution of research priorities from theoretical AI toward practical educational applications.

Highly cited publications serve as the conceptual pillars underpinning current developments in AI-enhanced mathematics.

Table 9. Top Funding Agencies (if available)

Rank	Funding Sponsor	Country/Region	Publications
1	National Science Foundation (NSF)	United States	8
2	National Natural Science Foundation of China (NSFC)	China	5
3	Ministry of Education	China*	3
4	Kultúrna a Edukačná Grantová Agentúra MŠVVaŠ SR (KEGA)	Slovakia	3
5	Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM)	Mexico	3
6	Fundação para a Ciência e a Tecnologia (FCT)	Portugal	3
7	European Commission	European Union	3
8	University of Utah	United States	2
9	University Grants Commission (UGC)	India	2
10	Science and Technology Commission of Shanghai Municipality	China	2

The **National Science Foundation (USA)** and the **National Natural Science Foundation of China** emerged as the leading funding organizations. Funding from governmental agencies, international organizations, and universities demonstrates broad institutional support for AI in mathematics research.

1) The funding landscape highlights the strategic importance attached to AI-driven mathematics research by national governments and international agencies.

Table 10. Keyword (Scopus)

Rank	Keyword	Frequency
1	Artificial Intelligence	229
2	Mathematics Education	118
3	Students	97
4	Teaching	95
5	Mathematics	65
6	Education Computing	60
7	Engineering Education	58
8	Learning Systems	50
9	Curricula	39
10	ChatGPT	35

Keyword analysis reveals the dominant research themes within the field. Besides **Artificial Intelligence**, the most frequent keywords include **Mathematics Education**, **Students**, **Teaching**, and **Mathematics**, confirming that educational applications remain the primary focus. The prominence of **Education Computing**, **Engineering Education**, and **Learning Systems** reflects growing integration of AI technologies into instructional environments. The appearance of **ChatGPT** among the top ten keywords demonstrates the rapid emergence of generative AI as a transformative topic, despite its relatively recent introduction.

Keyword trends indicate a shift from general AI applications toward intelligent tutoring, personalized learning, generative AI, and AI-supported mathematics instruction.

6. Conclusion

This study presents a bibliometric analysis of global research on **artificial intelligence (AI) in mathematics** using 497 publications indexed in the Scopus database between 1993 and 2026. The findings reveal a substantial increase in research output, particularly after 2020, highlighting the growing integration of AI technologies into mathematical research and mathematics education. The **United States and China** emerged as the leading contributors, while *Annals of Mathematics and Artificial Intelligence* was identified as the most productive journal. Keyword analysis indicates that

recent research has increasingly focused on **mathematics education, teaching, learning systems, educational computing, and generative AI technologies such as ChatGPT**, reflecting the evolving research priorities in the field.

Overall, the study demonstrates that AI in mathematics has become a rapidly expanding and interdisciplinary research domain supported by strong international collaboration. The findings provide valuable insights into publication trends, influential contributors, and emerging research themes, serving as a useful reference for researchers, educators, policymakers, and funding agencies. Since this study was limited to the Scopus database, future research may incorporate additional databases and advanced science-mapping techniques, such as co-authorship, co-citation, and thematic evolution analyses, to provide a more comprehensive understanding of the field.

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