Visualizing Research Trends in AI-Powered Mathematics Education: Insights from VOS Viewer Mapping

Parum Sarda*[1] and Shweta Loonkar[2] and Karishma Desai[3]

[1]CHIREC International School, Hyderabad, India, parumsarda@gmail.com

[2]Visiting Professor, MPSTME, NMIMS University, Mumbai, India, shwetaloonkar@gmail.com

[3]Adjunct Faculty, S.P Jain Global School of Management, Mumbai, India karishmamihirdesai@gmail.com

ABSTRACT:

Purpose:
This study aims to systematically map and analyse global research trends in AI-powered mathematics education, focusing on the adoption, effectiveness, and challenges of AI-driven tools in enhancing the teaching and learning of mathematics across diverse educational contexts.

Methodology:
A bibliometric review and visualization approach was employed. Relevant literature was sourced from major international meta databases, including Scopus, Web of Science (WoS), and IEEE Xplore. The search targeted article titles, keywords, and abstracts published between 2018 and 2025. VOS viewer was utilized to construct bibliometric maps identifying key themes, technological advancements, and collaborative research networks within the field.

Results:
Analysis of 120 peer-reviewed articles revealed predominant clusters in areas such as machine learning applications, adaptive learning platforms, and AI-driven assessment tools. Research output and collaborations are primarily concentrated in North America, Europe, and Asia. Among emerging themes, the use of AI to address math anxiety especially through culturally relevant, personalized interventions was identified as a significant but underexplored area, particularly in developing regions.

Conclusions:
This review highlights critical research gaps, emerging challenges, and future opportunities for scalable, ethical, and culturally sensitive AI solutions in mathematics education and personalized learning. The findings provide a valuable benchmark for researchers and policymakers seeking to maximize the educational impact of AI while addressing issues such as math anxiety in diverse learning environments.

Keywords: AI-powered mathematics education; VOS viewer; math anxiety; personalized learning

I. INTRODUCTION

As Henry Ford once said, innovation should not work only with what has been the norm, such as finding ways to breed faster horses, but it is necessary to search beyond what is the norm, creating something *new*. These views have driven swift developments in tech over the years. Especially in education (L. Chen et.al., 2020). One such new development is the use of AI in education. This branch of Computer Science can completely overhaul the kinds of interactions between the student, teacher, and institute. It can produce many positive outcomes such as time efficiency; energy efficiency; lowering the margins of human error and creating a new and improved learning environment for all who are involved (M. Zafari et.al., 2022). AI in math education can help solve the problems faced by students and teachers alike in the current system of math education.

Mathematics at its core is a tool used for the art of problem solving. It is the manipulation of numbers, fact, and knowns to find what is unknown. AI in math education can be used for many applications other than just to improve efficiency. Mathematics education has been identified as a complex and challenging task aiming to foster learners' problem-solving competence (Hwang et.al., 2021). However, there are many problems with this method of education. Multiple studies show that students struggle with this method of solving complex problems

V. Agarwal et al. (eds.), *Proceedings of the Global Innovation and Technology Summit "AAROHAN 3.0"_Engineering Track (GITS-EAS 2025)*, Advances in Engineering Research 295,
https://doi.org/10.2991/978-94-6239-644-9_16

repeatedly especially ones with a high number of steps involved (Paras J, 2001). In fact, there are studies which claim that math anxiety, which is detrimental to student mental health and their overall attitude towards math, can be a direct result of the current system of math education (Asare B et.al., 2025). In 2012 the Programme for international Student Assessment (PISA) had a study done across all of its 34 participating countries where it stated that 59% of 15–16-year-olds find math classes difficult, 33% get very tense while completing math homework and 31% get very nervous when doing math problems (Luttenberger et.al., 2018).

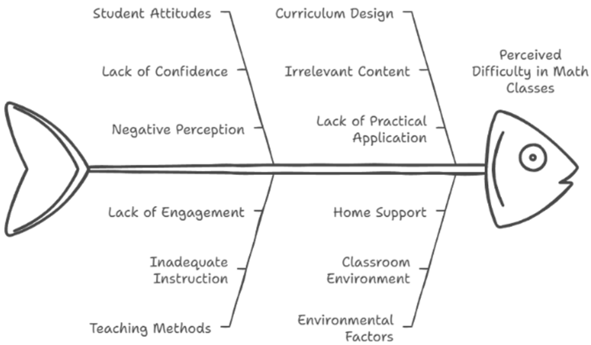

Fig.1 Causes of perceived difficulty in math classes.

Fig.1 shows the reason for the perceived difficulty in math classes. The first branch is of the student related issues. Students, partly due to the way mathematics is taught in most places and partly due to the lack of understanding that they have, fear mathematics. They do not perform well due to this fear and lose their confidence. This creates an overall negative perception of mathematics for most students. We can also understand that another problem is the curriculum design. The way they award memorization over understanding and following a plan to a tee instead of trying to connect with students is somehow rooted in the math educational culture. There is a lot of irrelevant content and lack of proper engagement.

Research on AI in Education (AIED) has taken the world of research by storm. These recent technologies have a lot of space for ideas and creating use cases. AIED has already produced meaningful results that have influenced the direction in which AI and other automated and emerging technologies are heading. Examples of this include intelligent tutoring systems, automated grading systems, sentiment analysis and routines that can conduct repeated tasks (Liu et.al., 2025). We can take insights from data to see how much these Emerging technologies can impact this field. Data taken from Statista shows that in 2025 around 22% of tasks are being performed by machines and this statistic is expected to rise to 34% in 2030. This shows a rising trend of technology replacing human tasks. This next data only covers the US, but it can still be relevant to our topic. The number of Ed-tech tools used in K-12 per district rose from close to 900 in 2018/2019 to almost 2800 in 2023/2024. This shows that the number of Ed-tech tools used has increased.

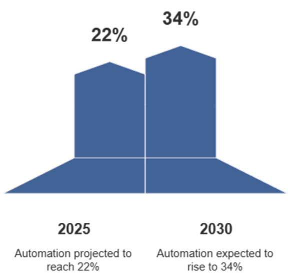

Fig 2 Projected Automation Growth in Various sectors

Fig.2 shows that automation in the field of math education is expected to rise by 12% in the next 5 years from 22% to 34%. This is another statistic that shows how AI in math education is expected to be on the rise. As automated tasks become increasingly common, time efficiency will rise as stated in the first paragraph. However, another key thing to consider is that despite the boom in the quantity and quality of AIED discussions often fail to consider the specifics such as higher education or even more specifically subjects that are highly objective such as mathematics, where the influence of AI could be much larger and lead to an even more efficient learning environment. These are areas in which AI can be even more transformative that in other fields (Maina et.al, 2024). Mathematics over the past few years has changed a lot with the developments in AI and increase in the technological skills of the people. This research paper gives us an idea of how these emerging technologies can be integrated into all forms of mathematics education (Bhardwaj, R. 2024).

The organization of the rest of the paper is as follows: Section 2 is a detailed literature review where we can analyse all the previous and even current research being done on this topic of AIED. Section 3 is a detailed account of the research methodology that was used including but not limited to the use of VOS viewer, and data from reliable sources such as IEEE, WOS and SCOPUS. Section 4 details all the results and infographics from which anyone can clearly analyse what the research has shown and will also include our policy recommendations. Section 5 is all about our conclusion and how we can move forward with this topic, it will include the future scope of this paper and how we can improve our results. The last section is our references.

II. LITERATURE REVIEW

In the field of Artificial intelligence there have been many advancements that are relevant to the betterment of Math education. These include Intelligent Tutoring Systems (ITS), Adaptive Learning Systems (ALS), Chatbots such as ChatGPT or DeepSeek, Automated Grading System etc. This section of the research paper is a deep dive into how these technologies have developed and improved and helped in the field of Math Education. Studies show that the ITSs' provision of context personalization has promoted learners' interest and by extension their performance in the kind of math tasks that require more steps. Another use of these AI systems is the use of chatbots such as ChatGPT to help ease the process of learning. Other types of unsupervised learning systems can help monitor and adapt the pacing, style, and rigor of the math course itself to help better align with the goals of education 5.0 (Hwang et.al., 2021). The use of ALSs has been incredibly significant in helping students with disabilities, such as ADHD or Dyslexia, process math. As stated in the introduction the current system of math education has caused a lot of problems for people who, for any reason, find it difficult to understand. This means that the use of ALSs can fix one of the most pressing problems that the current system of math education faces (Antara et.al 2024).

The use of AI chatbots can have positive feedback in many areas of math education. The attitude that the teachers have towards math is one of the main factors that influence how the students perceive these nine criteria: namely effectiveness, engagement, accessibility, personalization, feedback quality, confidence building, time efficiency, adaptability, and student satisfaction. The study's findings demonstrate an overall positive student feedback on AI chatbots such as ChatGPT, Gemini and Perplexity (J.F.P Luzano, 2024). Along with this there have been studies (Chih-Ming, 2008) from which we can say that by using AI technologies to try to understand and analyse student behaviours we can build ITSs, and by extension build a system that can align with the goals from education 5.0. With insights from Bronfenbrenner's Ecological Systems Theory, we can understand that for anyone, the people closest to them (their microsystem), influence them and their opinions the most. The people in their microsystem are the reason that they have their opinions on AI in education. This plays into the ethics of whether how much of AI can be implemented into the field of math education. These are the external Factors as described in the Technological acceptance model given by F D Davis (Li et.al., 2025).

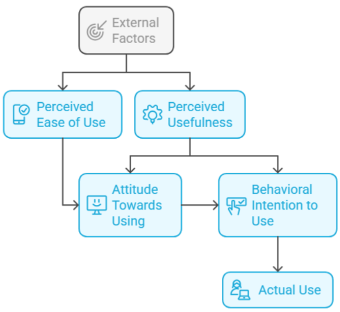

Fig 3. Technological acceptance model

Fig.3 Technological acceptance model is what shows us how new technologies will be perceived based on the factors that are in the model. External factors are factors that the creators cannot influence such as familial stances or government restrictions. Perceived ease of use and Perceived usefulness are both affected by how the technology is marketed. If a technology seems easy to use or especially useful then it is more likely for it to be used. This influences the users' attitude towards using the technology. If there is an overall positive view about using the technology, then it is more likely to be used. The behavioural intention to use the technology is closely related to how people perceive the product (their attitude towards using) and how useful they think it will be in their line of work. All or this leads to the product being used. The model is very useful in seeing how well a technology will be accepted. It is useful in the context of this paper to see how well what we currently call AI will fit into math education and if it does not it can help us identify what needs to happen for it to become fit for math education.

To be able to get people to use AI in math education we must see what the current circumstances are for the quality of math education. Analysis of data from the Southern African Consortium for Monitoring Education Quality (SACMEQ) shows that in the regions of Africa where the study was conducted 88% of students in grade 6 are at a grade 4 or lower math levels; only 10% of students in grade 5 could do 2-digit division; and 40% of those same students could not read a simple 1-paragraph story (Angrist et.al., 2022). Another issue that arises is that in many developing countries such as India there is a lack of training for teachers to be able to use these modern technologies, such as Gen AI, in their curriculum. Despite the government giving incentives in the form of grants it does not change the fact that a lot of teachers simply do not know how to use AI effectively at all. Another issue for teachers is that there is currently a language barrier for tools like ChatGPT or Mathway. There are close to a thousand traced languages in India alone and many more that are untraced. Infrastructure is also a point to consider as in developing countries they may not have the proper infrastructure to facilitate education with AI. All these factors along with opportunity costs for the funding for AI are the problems that AI Education is facing right now (Mandal et.al., 2025). These are some of the external factors that hinder the entrance of AI into math education in places like India. Despite AI in Education already being seen a lot in the western countries in the world, the use of AI in education remains mostly unexplored in areas like Southeast Asia. The findings revealed that educators in Singapore are most confident in AI's adaptability to cultural contexts, while those in Myanmar and Laos face challenges due to limited infrastructure to support AI education. Interviews highlighted the need to customize AI tools to align with students' cultural backgrounds, including language preferences and traditional learning practices, for effective implementation. Teacher training and access to technology, especially in rural areas, were also identified as critical factors (Payadnya et.al., 2024).

AI in math education has many advantages and disadvantages as seen in the paper so far. This emphasizes a need for a kind of strategy that capitalizes on the available technology while still upholding the core values of teaching and learning. AI tools such as ChatGPT, ITSs and Natural Language Processing (NLP) have and continue to transform education. Specifically, they have provided individualized learning, adaptive assessment, and instant feedback, which have opened opportunities for raising student engagement, student understanding and by proxy, student performance as well. However, to guarantee AI complements human teaching and does not replace it as problems such as a lack of creativity, emotional intelligence, and even a lack of privacy it beckons a solution in the form of Augmented Intelligence (Umoh et.al., 2025). Ensuring the ethical and responsible usage of these modern technologies in education will require a collaboration between educators, policymakers, and technology developers to establish airtight regulations that can provide students with privacy and promote fairness. It must also become an opportunity that can be accessed by all students, regardless of wealth, social status, or ethnicity. Ensuring them access to high quality digital infrastructure, affordable internet connectivity, and AI-powered education tools will become necessary with the goal of ensuring minimal educational disparities. Furthermore, ethical AI based governance must continue to evolve to minimise the bias in algorithmic decision making as data from many years ago can be a manipulation of statistics to try to prove an incorrect point. By giving the priority to ethical considerations alongside advancements in the technological sector, the future of AI in mathematics education can successfully balance innovation with inclusivity, shaping this field into a more effective and equitable learning platform (Aslam et.al., 2025). The tool that this paper uses to analyse the data and attempt to answer the research questions is a tool called VOSviewer. VOSviewer is a bibliometric analysis tool that can input bibliometric data and output infographics that can be used to easily analyse the data provided. The tool will be used regularly in the research methodology section to show how the conclusions are being made and how the research is being performed.

Table I. Literature Review Table to identify the research trends in AI-Powered Mathematics

Ref	Findings	AI tools mentioned	Pedagogical impact for math education	Research gap
(Mandal S et.al.,2025)	Low AI competencies in teachers	ChatGPT	Increasing effectiveness of AI	Lack of measurement for AI competencies
(Angrist N et.al., 2022)	Parents have a big impact on learning	No AI tools mentioned	Math skills improve with parental involvement	Lack of low-cost functional learning systems
(Hwang G et.al., 2021)	AI is becoming better at math-education.	ML algorithms, ITSs	AI in math-ed improves feedback and reduces teachers' workload.	how AI can curate personalized learning in math-ed
(Payadnya et.al., 2024)	Southeast Asian teachers see AI as culturally adaptable	No AI tools mentioned	AI enhances math-ed by giving personalized learning	The limitations of AI for cultural adaptations
(Li et.al., 2025)	teachers' attitudes & TPACK influence AI in primary math classrooms.	ITSs, ML-driven assessment platforms	AI tools can better instruction, engagement, and give immediate feedback.	How teachers, external factors and AI fit into primary math-ed
(L. Chen et.al., 2020)	AI improves assessment efficiency.	TurnItIn, Grammarly, Ecree etc.	AI can completely change how math is taught.	How AI's Long-term impacts affect teachers
(M. Zafari et.al., 2022)	AI enhances teaching and student evaluation.	RF, SVM, DL, NLP	AI has potential to improve math-ed and provide deep learning.	Limitations in better strategies for AI in K-12 math-ed.
(Luttenberger et.al., 2018)	Math anxiety impairs academic performance.	No AI tools mentioned	The paper shows the negative impacts of math anxiety.	Limited long-term studies on math anxiety.
(Liu et.al., 2025)	AI enhances engagement and understanding.	Many AI tools that are applied in engineering	This paper is a meta-analysis into how AI helps in math-ed	Not enough research on the long-term effects of AI in engineering-ed
(Ahmad et.al., 2023)	AI enhances ed tools, but has bias, privacy, and security issues.	Qbot, ITSs, MyEdMatch, TeacherMatch, Pepper and NAO	This paper integrates AI tools improving engagement and performance results.	Limited focus on AI's effectiveness in many contexts.
(Maina et.al., 2024)	AI has potential, but faces skills, and policy barriers.	ITSs, chatbots, and other research-based AI tools	This paper highlights AI-driven math-ed approaches.	Limited specific AI applications for challenges faced in Africa
(Antara et.al., 2024)	Math-manipulatives better math learning.	augmented reality (AR) educational software	This paper promotes inclusive teaching strategies for diverse learners.	Limitations of AI tools' effects on math-ed for disabled students

Following an extensive review of relevant literature, a comprehensive literature review table was constructed to synthesize existing work AI, its effects on Math Anxiety and its effects on Math Education. This synthesis enabled the identification of key gaps, including the limited research done on math how AI and education systems can influence math anxiety, and how AI is affecting education systems. Building upon these insights, the subsequent stage of this study focuses on formulating a rigorous research methodology designed to address the stated research questions and hypotheses. The proposed methodology encompasses systematic data acquisition, multi-source feature engineering, model development, and comparative evaluation through the use of VOS viewer. By aligning the methodological framework directly with the gaps revealed in the literature, this approach ensures that the empirical analysis is both targeted and capable of generating reproducible, evidence-based conclusions suitable for real-world application.

RESEARCH QUESTIONS

1. What are the predominant themes, technologies and collaborative networks in AI-powered Mathematics education Worldwide?
2. How do AI-powered tools impact student learning outcomes, teacher efficiency, and mitigation of Math Anxiety in different cultural and educational settings?
3. What are the emerging challenges and opportunities in developing scalable, ethical, and personalized AI solutions for Mathematics education, particularly in underrepresented regions?

HYPOTHESES

1. Research output and collaborative networks in AI-powered mathematics education are concentrated in a few regions, with notable gaps in representation from developing countries.
2. The integration of AI-powered tools in mathematics education significantly improves student learning outcomes and reduces Math anxiety compared to traditional methods.
3. Personalized and culturally tailored AI-driven learning systems are more effective in enhancing student engagement and teacher efficiency than generic AI solutions.

III. RESEARCH METHODOLOGY

The research design adopted a theoretical and bibliometric analysis design. VOS viewer was used as the main tool to map and visualize trends in AI-powered mathematics education. A systematic literature collection strategy was employed to ensure comprehensiveness and validity.For data collection, data was collected from Scopus, Web of Science, and IEEE Xplore as they are compatible with VOS viewer. Keywords included a combination of terms such as "Artificial Intelligence", "AI-powered", "Mathematics Education", "Math Anxiety", and "personalized learning". Inclusion criteria consisted of peer-reviewed journal articles, conference proceedings, and review papers from the years 2018 to 2025. Exclusion criteria included non-English articles and papers without abstracts or metadata. Data processing involved exporting bibliographic data such as authors, titles, abstracts, keywords, references, and affiliations. The data was then cleaned and pre-processed by removing duplicates, standardizing author names, and unifying synonyms of keywords like “AI” and “Artificial Intelligence”.

Bibliometric analysis with VOS viewer was conducted. First, co-authorship analysis (for RQ1 and Hypothesis 1) mapped collaborative networks among authors, institutions, and countries, identifying regions dominating research output and highlighting underrepresented areas. Second, keyword co-occurrence analysis (for RQ1 and RQ3) extracted predominant themes, trending topics, and technological focus areas, while identifying research gaps and emerging challenges such as ethical AI, personalization, and scalability. Third, co-citation and bibliographic coupling (for RQ2 and Hypothesis 2) revealed theoretical foundations and influential works on AI tools in mathematics education, and analysed clusters related to student learning outcomes, math anxiety, and teacher efficiency. Fourth, thematic evolution mapping (for RQ3 and Hypothesis 3) tracked emerging sub-themes such as personalized AI, cultural adaptation, and equity in education, and visualized shifts over time from early AI adoption to personalized solutions.

In linking to research questions and hypotheses, RQ1 and Hypothesis 1 used co-authorship and geographic distribution maps to prove concentration of research in developed countries versus gaps in developing regions. RQ2 and Hypothesis 2 used co-citation clusters to show that literature increasingly links AI tools with positive outcomes like reduced math anxiety and improved learning, while also comparing clusters on traditional pedagogy versus AI-supported pedagogy. RQ3 and Hypothesis 3 used keyword evolution and thematic analysis to show the rise of personalized AI systems and compared the effectiveness of culturally contextualized AI models versus generic approaches based on mapped studies. The theoretical perspective positioned the findings within Educational Technology Theories such as Constructivism, Cognitive Load Theory, and the Technology Acceptance Model. The role of AI in enhancing student-centred learning and teacher facilitation was discussed.

The outcomes of the methodology were a visual knowledge map of AI-powered mathematics education, identification of research gaps especially in underrepresented regions, and theoretical justification of the hypotheses using bibliometric evidence. Bibliometric Analysis with VOS viewer included several stages. Co-authorship analysis mapped collaborative networks across authors, institutions, and countries. It provided insights into the concentration of research output and identified underrepresented regions, thereby addressing RQ1 and supporting Hypothesis 1. Keyword co-occurrence analysis identified predominant themes and emerging technologies in AI-powered mathematics education. This contributed to the understanding of RQ1 and RQ3 while uncovering challenges and opportunities in scalable and ethical AI adoption. Co-citation and bibliographic coupling examined frequently co-cited sources, identifying theoretical foundations and influential works. These clusters revealed the extent to which AI tools are associated with outcomes such as improved learning, teacher efficiency, and reduced math anxiety, thereby addressing RQ2 and supporting Hypothesis 2. Thematic evolution mapping highlighted the progression of research themes, from general AI adoption to culturally tailored and personalized AI-driven learning systems. This analysis supported RQ3 and validated Hypothesis 3.

Linking analysis to research questions and hypotheses was structured as follows. For RQ1 and Hypothesis 1, co-authorship and regional mapping demonstrated whether research and collaboration are concentrated in specific regions, confirming the geographic disparity in AI-powered mathematics education. For RQ2 and Hypothesis 2, co-citation and bibliographic coupling identified clusters of studies linking AI tools with enhanced learning outcomes, teacher efficiency, and reduced math anxiety compared to traditional pedagogical approaches. For RQ3 and Hypothesis 3, keyword co-occurrence and thematic evolution highlighted the rise of personalized and culturally contextualized AI systems, establishing their effectiveness relative to generic solutions. The theoretical perspective interpreted findings through established educational technology frameworks, including Constructivism, Cognitive Load Theory, and the Technology Acceptance Model (TAM). This theoretical lens facilitated an understanding of how AI-powered mathematics education supports student-centred learning, enhances teacher facilitation, and addresses challenges such as math anxiety and equity in underrepresented regions.

IV. RESULTS & DISCUSSIONS

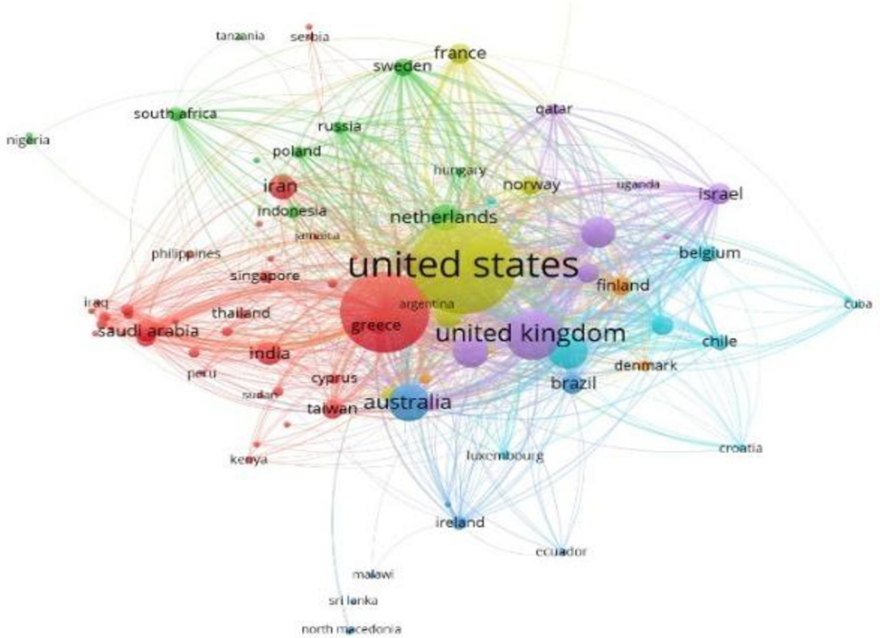

Fig 4. Country-based Network visualisation with search keywords "AI" and "Math Education"

Fig 4 shows a network visualisation with the keywords "AI" and "Math Education" and it looks at the countries that have produced research about the keywords. There is a total of 95 countries that fit the description among which the United States has the largest amount of research published, closely followed by China. This proves

Hypothesis 1 as there is a very small amount of research published by developing countries and the research is mostly focused around two countries.

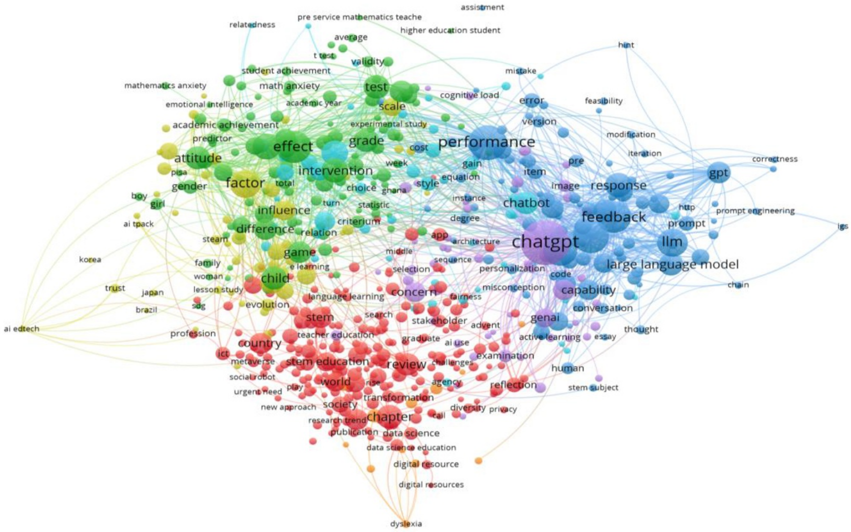

Fig 5. Keyword-based Network Visualisation with search keywords “Math Education Systems” and “AI”

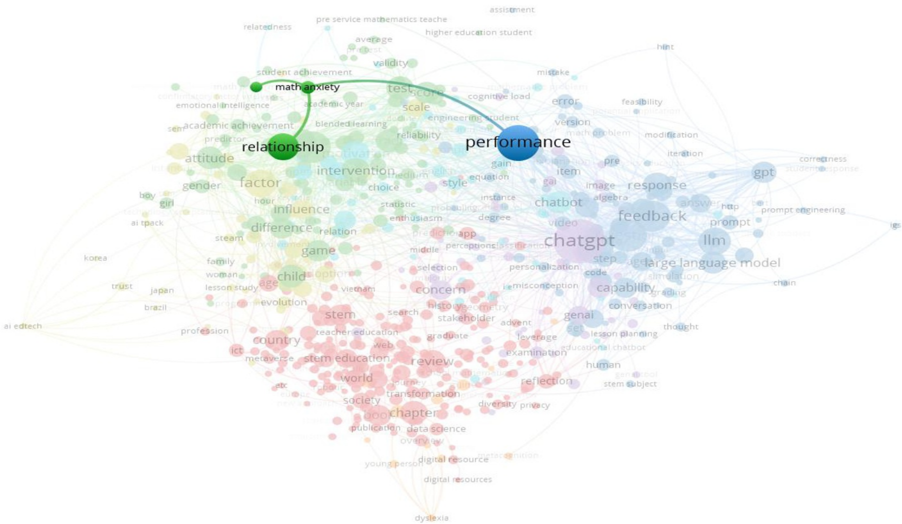

Fig 6. Keyword-based Network Visualisation with search keywords “Math Education Systems” and “AI” with highlighted keyword “Math Anxiety”

Fig 5 and Fig 6 show a mapping of text data extracted from the bibliometric data with the keywords “Math Education Systems and AI”. The paper only takes into consideration the top six hundred keywords. However, even among the top six hundred there is a large disparity among the significance of the keywords. Fig 5.2 shows the mapping specific to the keyword “Math anxiety”. As we can clearly see Math Anxiety, despite being one of the top six hundred keywords is extremely underrepresented compared to keywords such as ChatGPT of

Feedback. Even so Math Anxiety research has clearly increased over the last few years even becoming one of the top six hundred keywords when it comes to "AI and Math Education Systems."

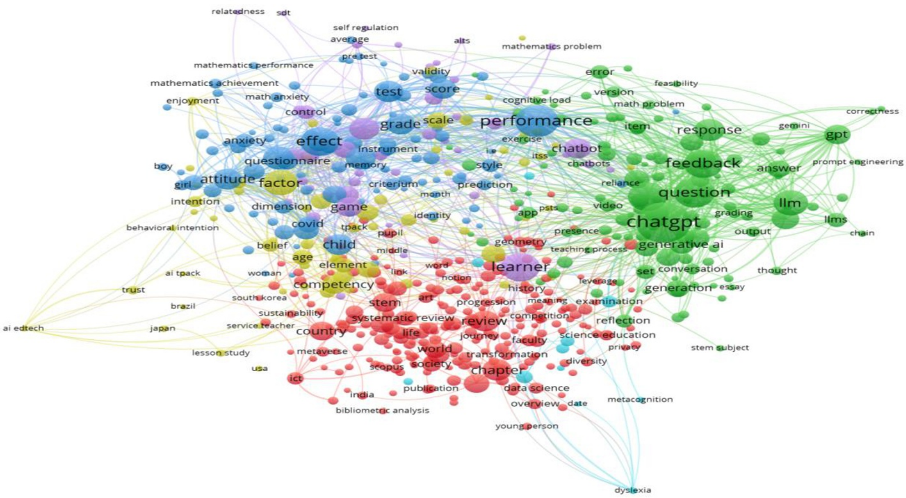

Fig 7. Keyword-based Network Visualisation with search Keywords "Education Systems" and "Math Anxiety"

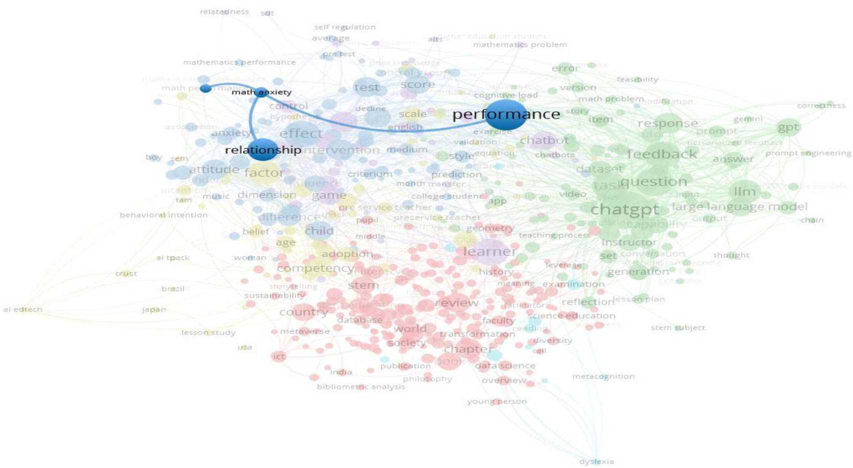

Fig 8. Keyword-based Network Visualisation with search Keywords "Education Systems" and "Math Anxiety" with highlighted keyword "Math Anxiety"

Fig 7 and 8 show the keyword mapping of the prompt "Education Systems AND Math Anxiety". Math Anxiety as a keyword has only recently been researched with the rise of AI. This proves Hypothesis 2. However, it is still not fully one of the most prominent keywords and only has three links in the network diagram: namely with math performance, performance and relationship. This shows that math anxiety is mostly only researched alongside performance and relationship but not with Education Systems as a whole.

V. CONCLUSION & FUTURE SCOPE

This study systematically analysed global research trends in AI-powered mathematics education using bibliometric mapping through VOSviewer. The results provide insights into how AI is being integrated into mathematics education, its potential in reducing math anxiety, and the broader implications for teaching and learning practices.

Keyword and Co-authorship Mapping

Figure 4 shows the co-authorship network for publications containing the keywords “AI” and “Mathematics Education.” A total of 95 countries were identified as contributors to the field, with the United States and China producing the largest volume of research output. This concentration of research aligns with Hypothesis 1, which suggested that collaborative networks and publications are heavily skewed towards developed regions, while developing countries remain underrepresented. The dominance of these regions suggests that access to resources, infrastructure, and research funding continues to shape the distribution of AI research in education.

Emerging Themes and Underrepresentation of Math Anxiety

Figures 5 and 6 highlight the keyword co-occurrence analysis of “AI” and “Math Education Systems.” Although over six hundred keywords were analysed, “Math Anxiety” only recently emerged as a visible term within the top six hundred, and even then, it remained significantly underrepresented compared to dominant terms such as “ChatGPT” or “Feedback.” This finding underscores a research gap in linking AI adoption to student emotional well-being, despite growing recognition of math anxiety as a critical issue in learning outcomes. Hypothesis 2 is partially confirmed, as the results show that AI-related research has only begun to engage with the topic of math anxiety, and largely in connection with performance or learning outcomes, rather than as an independent construct within education systems.

Network Links and Thematic Associations

Figures 7 and 8 map the relationships between “Education Systems” and “Math Anxiety.” The keyword “Math Anxiety” shows only three major links—to performance, math performance, and relationship. This limited connection demonstrates how the discourse remains narrowly framed around achievement metrics rather than holistic or systemic perspectives. These patterns suggest that while AI has been widely adopted to improve efficiency, feedback, and personalization, there is limited work connecting these innovations directly to student well-being and psychological barriers to learning.

Integration of AI and Theoretical Alignment

The findings support the hypotheses that personalized AI systems and culturally contextualized models hold significant promise for addressing student needs. For example, the rise of chatbots, adaptive learning platforms, and intelligent tutoring systems aligns with the Technology Acceptance Model and Constructivist perspectives, which emphasize usability and learner-centred engagement. At the same time, the lack of research in underrepresented regions highlights issues of equity and access, echoing calls for ethical AI solutions tailored to diverse educational contexts.

Implications for Policy and Practice

Taken together, these findings suggest that AI-powered education research has progressed rapidly in terms of technological innovation but remains uneven in addressing social and psychological challenges. Researchers and policymakers should consider directing efforts toward integrating AI not just as a performance-boosting tool, but as a mechanism to reduce barriers such as math anxiety and promote equitable participation across global contexts. Future studies should explore longitudinal impacts of AI adoption on student confidence and mental health, especially in developing countries where infrastructure gaps persist.

Limitations

A key limitation is the underrepresentation of primary empirical studies directly measuring the impact of AI on math anxiety, which limits the ability to draw causal inferences. In addition, while bibliometric analysis identifies themes and collaborations, it does not directly measure classroom outcomes. These limitations point to the need for mixed-methods research combining bibliometric mapping with experimental or longitudinal designs to better capture the complex role of AI in shaping mathematics education.

REFERENCES

1. L. Chen, P. Chen and Z. Lin, "Artificial Intelligence in Education: A Review," in IEEE Access, vol. 8, pp. 75264-75278, 2020, DOI: 10.1109/ACCESS.2020.2988510.
2. M. Zafari, J. S. Bazargani, A. Sadeghi-Niaraki and S. -M. Choi, "Artificial Intelligence Applications in K-12 Education: A Systematic Literature Review," in IEEE Access, vol. 10, pp. 61905-61921, 2022, DOI: 10.1109/ACCESS.2022.3179356.
3. Hwang G., & Tu, Y. (2021). Roles and Research Trends of Artificial Intelligence in Mathematics Education: A Bibliometric mapping analysis and Systematic review. Mathematics, 9(6), 584. https://doi.org/10.3390/math9060584
4. Paras, J. (2001). Crisis in mathematics education. Student failure: challenges and possibilities. South African Journal of Higher Education, 15(3) https://doi.org/10.4314/sajhe.v15i3.25327
5. Asare, B., Arthur, Y. D., & Al-Hassan, A. (2025). Moderating effect of math anxiety and the mediating role of student self-efficacy on the nexus between cognitive awareness and student math performance. Journal of Applied Research in Higher Education. https://doi.org/10.1108/jarhe-07-2024-0365
6. Luttenberger, S., Wimmer, S., & Paechter, M. (2018). Spotlight on math anxiety. Psychological Research and Behavior Management, Volume 11, 311–322 https://doi.org/10.2147/prbm.s141421
7. Liu, Cong, Guang-Chao Wang, and Hong-Feng Wang. "The application of artificial intelligence in engineering education: a systematic review." *IEEE Access* (2025). https://doi.org/10.1109/access.2025.3532595
8. Ahmad, Kashif, et al. "Data-driven artificial intelligence in education: A comprehensive review." *IEEE Transactions on Learning Technologies* 17 (2023): 12-31.
9. Paul, Justin, and Alex Rialp Criado. "The art of writing literature review: What do we know and what do we need to know?" *International business review* 29.4 (2020): 101717.
10. Maina, Anthony M., and Jane Kuria. "Building an AI Future: Research and Policy Directions for Africa's Higher Education." *2024 IST-Africa Conference (IST-Africa)*. IEEE, 2024.
11. Bhardwaj, R. (2024, May). AI Integrated Model Design for Education System for Analytical Computation (Mathematics). In *2024 4th International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE)* (pp. 1412-1417). IEEE. DOI: 10.1109/ICACITE60783.2024.10616503
12. Antara, I. G. W. S., Widiana, I. W., & Jampel, I. N. (2024). Assistive Technology in Mathematics Education: Investigating the Effectiveness of Math Manipulatives for Students with Disabilities. *International Journal of Elementary Education*, *8*(3), 519–527. https://doi.org/10.23887/ijee.v8i3.85378
13. Luzano, J.F.P (2024). Reshaping mathematics instruction via impact of AI chatbots on secondary education pre-service teachers. International Journal of Studies in Education and Science (IJSES), 5(3), 233-245. https://doi.org/10.46328/ijses.97
14. Chih-Ming Chen, Intelligent web-based learning system with personalized learning path guidance, Computers & Education, Volume 51, Issue 2, 2008, Pages 787-814, ISSN 0360-1315, https://doi.org/10.1016/j.compendu.2007.08.004
15. Li, M., & Manzari, E. (2025). AI utilization in primary mathematics education: a case study from a southwestern Chinese city. *Education and Information Technologies.* https://doi.org//10.1007/s10639-025-13315-z
16. Angrist N., Borgman, P., & Matsheng, M. (2022). Experimental evidence on learning using low-tech when school is out. *Nature Human Behaviour, 6*(7), 941–950. https://doi.org/10.1038/s41562-022-01381-z
17. Mandal S., Bakshi, A., & Sereen, S. (2025). Examining teachers' competencies in generative AI-enabled higher education: scale development and validation for empirical research. *SN Social Sciences, 5*(4). https://doi.org/10.1007/s43545-025-01068-y
18. Payadnya, I. P. a. A., Putri, G. a. M. A., Suwija, I. K., Saelee, S., & Jayantika, I. G. a. N. T. (2024). Cultural integration in AI-enhanced mathematics education: insights from Southeast Asian educators. *Journal for Multicultural Education.* https://doi.org/10.1108/jme-09-2024-0119
19. Umoh E., Boniface, Artificial Intelligence and the Future of Teaching and Learning Mathematics in a Global Context: An Overview of Contemporary Research (February 03, (2025). Available at SSRN: https://ssrn.com/abstract=5126695 or http://dx.doi.org/10.2139/ssrn.5126695
20. Aslam, Umair & Abbas, Anwar. (2025). Ethical AI and ICT Integration in Mathematics Education: Enhancing Lifelong Learning Through Blended Synchronous Learning. 10.13140/RG.2.2.30393.68969.
21. Sharma, A. (2025). The Psychological Impact of High-Stakes Testing: Investigating the Effects of NEET/JEE Pressure on Students; Mental Health and Well-Being. *American Journal of Psychiatric Rehabilitation*, *28*(5), 102-110. DOI:10.69980/ajpr.v28i5.331