

Review Article

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A Bibliometric and Systematic Analysis of Mathematics Interest (2021-2025)

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Abstract

Background/purpose. Student interest in mathematics plays a significant role in supporting their motivation and academic achievement. However, research in this area remains scattered and lacks a clear direction. This study was conducted to identify the development, trends, and research gaps in mathematics interest research between 2021 and 2025.

Materials/methods. This study combined bibliometric analysis with a systematic review to examine 639 articles from the Web of Science database. The analysis identifies the most active journals, authors, and countries contributing to the field. Keyword co-occurrence and network analysis were used to explore dominant and emerging themes, while co-citation and content analysis helped reveal how ideas in the field are connected.

Results. Five main themes identified in this research were student motivation and engagement, self-efficacy and self-regulation, expectancy-value theory and self-concept, emotional aspects of learning, beliefs about intelligence and gender equity. The findings show a growing interest in how cognitive, emotional and social factors influence mathematics interest. However, the study also found that long-term and cross-cultural research in this area is still limited.

Conclusion. Mathematics interest is a multidimensional concept shaped by both personal beliefs and external influences. Understanding these influences is important for developing effective strategies to improve student engagement and achievement. This study highlights the diverse theories and limited cross-cultural research on mathematics interest, offering a strong foundation for designing interest-based teaching and guiding future research in mathematics education.

1. Introduction

Mathematics plays a fundamental role in education, supporting students' academic development, especially in fields such as science, technology and engineering. Developing an interest in mathematics will not only enhance students' motivation to engage with the subject but also reinforce skill development (Hidi & Renninger, 2006). According to Fisher et al. (2012), children's early interest in mathematics and their developing math skills are mutually reinforcing, with each contributing to the growth of the other over time. Furthermore, mathematical interest is closely linked to increased engagement, persistence, and intrinsic motivation, all of which ultimately contribute to higher academic achievement (Du et al., 2021; Singh et al., 2002; Stevens et al., 2006). Mathematics interest has been widely recognised as a key factor influencing students' performance (Arhin & Yanney, 2020; Kihwele & Mkomwa, 2023; Salifu & Bakari, 2022). However, research on this topic is scattered and varies in focus, making it challenging to understand the overall direction of the field.

This paper explores research on mathematics interest using Web of Science (WoS) database, which is widely used in bibliometric analysis due to its high-quality, peer-reviewed content and broad academic coverage (Mongeon & Paul-Hus, 2016; Zupic & Čater, 2015). The study covers the period of 2020 to April 2025 a period that saw major changes in education delivery due to the COVID-19 pandemic. During this timeline, students experienced diverse learning modalities, including online learning, distance learning, blended learning, hybrid models and traditional classroom instruction. By focusing on this specific period, the study aims to identify shifts in students' interest in mathematics as well as broader trends in mathematics education. The findings from a review offer valuable direction for future research and highlight gaps that warrant further exploration in the field (Ismail et al., 2024).

Table 1. Overview of existing reviews in the mathematics interest (2020-2024)

Author (Year)	Scope of review	Method
Shibeshi (2020)	Review on students interest and self-motivation to learning mathematics education in Ethiopian	Narrative Review
Scherrer et al. (2020)	Development of achievement goals and their relation to academic interest and achievement in adolescence: A review of the literature and two longitudinal studies	Literature Review and Empirical
Ili et al. (2021)	Relationship between student learning interest and mathematics learning achievement: A meta-analysis	Meta-analysis
Hui and Mahmud (2023)	Influence of game-based learning in mathematics education on the students' cognitive and affective domain: A systematic review	Systematic Review
Schukajlow et al. (2023)	Emotions and motivation in mathematics education: Where we are today and where we need to go	Conceptual Review
Habimana et al. (2024)	Factors affecting secondary school students' interest to learn mathematics: A review of the literature	Literature Review
Setyaningsih et al. (2024)	Augmented reality in influencing interest in learning mathematics	Empirical study

Table 1 presents the seven recent review studies on mathematics interest from 2020 to 2024. These studies applied various methods, including narrative reviews, literature reviews, conceptual reviews, systematic reviews, meta-analyses and empirical studies. They examined how emotional, motivational, and contextual factors influence students' interest in mathematics. For instance, both Shibeshi (2020) and Schukajlow et al. (2023) highlighted the influence of students' internal factors, such as emotional responses and motivational roles, in shaping their mathematics interest. External factors such as classroom environments, sufficient learning material, and learning support (Shibeshi, 2020) and internal factors such as enjoyment, appreciation, self-efficacy, and engagement (Schukajlow et al., 2023) significantly affect students' interest and motivation to learn. Similarly, Habimana et al. (2024) discovered that teaching strategies and materials, teacher support, and student perspectives towards mathematics influence interest in mathematics learning. Meanwhile, some studies explored interactive approaches via technology-based methods such as game-based learning (Hui & Mahmud, 2023) and augmented reality (Setyaningsih et al., 2024) to increase students' motivation, engagement, and interest in mathematics.

In terms of learning outcomes, Ili et al. (2021) conducted a meta-analysis and reported a clear positive relationship between students' mathematics interest and their academic performance. This finding is further supported by Scherrer et al. (2020), who found through longitudinal studies that students with strong achievement goals tend to develop greater interest and achieve better results in mathematics. Overall, these studies suggest that both internal factors, like motivation and emotions, and external factors, such as teaching methods and classroom environment influence students' interest in mathematics.

Despite the growing attention to this topic, a clear gap remains in the literature, as only a few studies have examined mathematics interest using bibliometric methods. Although bibliometric analysis has gained popularity in broader educational research, little attention has been given to analysing publication trends, collaboration patterns, and influential articles within the field of mathematics interest. Therefore, this study aims to fill that gap by integrating bibliometric analysis with a systematic review. This combined approach offers a more comprehensive understanding of how mathematics interest has been studied, what themes have emerged, and where future research is needed (Cheng et al., 2023).

2. Literature Review

In the theoretical dimension of mathematics interest, the concept is defined as an attitudinal and affective variable that reflects a learner's positive feelings, motivation, and personal engagement with mathematics, which can influence their learning outcomes (Singh et al., 2002). When students are interested in mathematics, they are more likely to enjoy the learning process, stay motivated, and continue learning even when faced with challenges (Schukajlow & Rakoczy, 2016). Researchers generally classify interest into two main types, which are situational interest and individual interest (Hidi & Renninger, 2006). Situational interest refers to a short-term form of interest, often triggered by engaging tasks where the student is focused, enjoys the activity and sees value in it (Martinussen et al., 2025). However, this type of interest may be temporary unless supported consistently over time. In contrast, individual interest is more stable and long-lasting. It reflects how much a student enjoys and values mathematics as part of their academic development (Hidi & Renninger, 2006).

Interest includes both cognitive and affective aspects, which together shape how students engage with learning (Carmichael et al., 2017; Krapp, 2007). The affective part involves emotions such as enjoyment, curiosity, or anxiety. For example, Schukajlow et al. (2023) emphasized that enjoyment and appreciation can increase motivation, while negative emotions like fear and frustration can reduce interest. On the other hand, the cognitive component includes attention, mental effort, and the perceived value of mathematics. Students who believe mathematics is useful for their future are

more likely to show sustained interest and maintain engagement (Eccles & Wigfield, 2002). Despite the growing research in this area, a gap remains in understanding how self-efficacy (Bandura, 1997) and self-regulated learning processes (Zimmerman, 2008) contribute to the development of individual interest in mathematics, particularly across different educational contexts.

In the context of emotional and social factors, the development of mathematical interest is influenced by both internal and external factors. Internal factors include students' attitudes, confidence and previous experiences in mathematics. External factors involve teaching methods, classroom environment, access to materials and teacher support (Habimana et al., 2024; Shibeshi, 2020). Emotional experiences such as enjoyment, frustration, and anxiety also shape how students relate to mathematics (Pekrun et al., 2011). Positive emotions can enhance persistence and engagement, whereas negative experiences may cause students to disengage (Pekrun, 2006). Social interactions in classrooms, such as peer collaboration and supportive teacher-student relationships, further influence interest formation and retention (Patrick et al., 2007).

Numerous studies have shown that mathematics interest is positively associated with mathematics performance (Ahmad et al., 2024; Harefa, 2023; Thomas & Ali Mohammed, 2024). Interested students tend to participate more actively in lessons, apply effective learning strategies and perform better on assessments (Andamon & Tan, 2018; Maamin et al., 2022; Schukajlow & Rakoczy, 2016). This pattern was further confirmed by Ili et al. (2021) in a meta-analysis, which found a strong correlation between mathematics interest and academic achievement. Similarly, Scherrer et al. (2020) found that students with mastery goals who focus on understanding concepts tend to maintain higher interest levels and perform better. While these findings are well supported, there remains a need for more integrated research to explore how emotional and social factors interact in influencing interest and achievement, particularly among underrepresented groups (Hannula, 2006).

In terms of educational interventions, various strategies have been implemented to enhance students' interest in mathematics and improve their performance. Huang et al. (2020) showed that activities such as student-created tutorial videos and collaborative media projects can boost engagement. Asmira et al. (2021) found that implementing a Problem-Based Learning (PBL) approach significantly improved students' interest and achievement in mathematics over two learning cycles. Other creative strategies, such as the King and Queen of Mathematics Intervention (KQMI) (Kihwele & Mkomwa, 2023) and flipped classroom methods (Egara & Mosimege, 2023), have demonstrated success in improving student outcomes.

Emerging technologies have also played a role in enhancing interest. Studies using game-based learning approaches (Hui & Mahmud, 2023) and augmented reality tools (Setyaningsih et al., 2024) have been found to make learning more enjoyable and interactive. Yeh et al. (2019) also highlighted how digital interventions tailored to student needs can sustain motivation and deepen conceptual understanding. Although these interventions show promise, limited studies have evaluated their long-term effects on sustaining individual interest and overall achievement, suggesting the need for longitudinal designs and cross-cultural validation (Ainley et al., 2002; Renninger & Hidi, 2016).

To further understand trends and gaps in mathematics interest research, bibliometric methods are useful in organizing large amounts of data related to publication output, co-authorship and keyword networks (Donthu et al., 2021; Merigó & Yang, 2017). Through bibliometric and content analysis, this study aims to explore the evolution of scholarly focus over time, identify dominant and emerging themes, and highlight influential authors, journals, and frameworks. Such an approach provides a structured overview of current knowledge and uncovers areas requiring further investigation, especially in mathematics education.

The primary objective of this study is to explore the present state of mathematics interest in learning and its influence in mathematics achievement. To better understand the focus of this investigation, the research questions below have been formulated.

1. How has scholarly output on mathematics interest evolved between 2021 and 2025, and which journals, authors, and countries have contributed most to its development?
2. What are the dominant and emerging themes in mathematics interest research based on keyword co-occurrence and network analysis from 2021 to 2025?
3. What is the intellectual structure of mathematics interest research as revealed through co-citation analysis and thematic content analysis between 2021 and 2025?

3. Methodology

Methodology is a systematic and organised way to do research to achieve research objectives (Creswell & Creswell, 2017). Basically, it gives a clear plan or structure that helps explain how the research process is carried out. This section is divided into two parts. The first part explains the data collection and search procedures, while the second part describes the data analysis methods used in the study.

3.1. Data collection and search procedure

The bibliometric data from 1986 to 2025 were obtained from the Web of Science (WoS) database. The first articles were published in the year of 1986 itself. The Web of Science (WOS) database was chosen as it is one of the earliest and most established sources commonly used in bibliometric research (Pranckutė, 2021). Although some researchers recommend using multiple databases like WoS and Scopus, this can lead to duplicate records and complicate data analysis. Since many journals appear in both, using a single, high-quality source like Web of Science is often sufficient (Öztürk et al., 2024). Therefore, this study used only WoS to ensure consistency and avoid unnecessary complexity.

All data retrievals and exports were performed on the same day in April 2025 to avoid inconsistencies or errors that might result from updates to the database (Gargi et al., 2024). To explore the role of mathematics interest within the broader context of mathematics education, a comprehensive bibliometric and systematic review was conducted. The search strategy included keywords such as 'interest', 'motivation', 'engagement' and 'attitude' to capture related constructs frequently associated with the development and impact of mathematics interest. Terms such as 'academic achievement' and 'educational outcomes' were included to identify studies examining its influence on performance.

The search was initiated using the keywords ("interest" OR "engagement" OR "motivation" OR "attitude") AND ("mathematics" OR "math" OR "numeracy" OR "arithmetic") AND ("academic performance" OR "academic achievement" OR "scholastic success" OR "educational outcomes") are relevant to the theme of 'mathematics interest and mathematics performance' resulting in a total of 2,220 records. Narrowing the search to articles published between 2021 and 2025 reduced the results to 823. Further restricting the search to English-language articles reduced the number to 790. Refining the search to include only articles brought the total down to 728. Finally, after excluding articles that did not fit the specific journal categories, 639 articles remained. VOSviewer was utilized in this bibliometric analysis to generate network maps based on similarity data, owing to its strong capabilities in visualizing complex bibliometric relationships and handling large datasets effectively (Bukar et al., 2023; van Eck & Waltman, 2010). The data search procedure is described in Table 2.

Table 2. Exploration details

Exploration Criteria	No. of Articles
First article published in	1986
Searched original (1986 – 2025)	2220
From year 2021-2025	823
Language	790
Articles	728
Categories	639

3.2. Data analysis

This research uses both bibliometric analysis and content analysis to explore and gain a deeper understanding of the existing literature on mathematics interest. Each method has its own scope and focuses on different aspects of the data. Figure 1 illustrates the overall data analysis process used in this study.

Bibliometric analysis is a quantitative approach applied to address research questions 1 and 2. This method examines patterns in academic literature, revealing research output, key authors, and collaborations among researchers, institutions, and countries (Özkaya, 2018). It typically involves analysing publication counts, citation frequencies and co-authorship or keyword networks to reveal patterns in a research field (Donthu et al., 2021; van Eck & Waltman, 2017).

To explore patterns in mathematics interest research, bibliometric data were drawn from the Web of Science (WoS) database. The analysis focused on identifying publication trends over time and determining influential publications, as well as the most active journals, countries and authors. To visualize the results, we used VOSviewer, which generated network maps showing keyword co-occurrence, author collaborations and citation relationships (van Eck & Waltman, 2010). These visualizations helped identify prominent researchers and emerging topics in mathematics interest research. Additionally, Microsoft Excel was used to organize the data and present findings in clear tables and charts, improving the interpretability of the results (Moral-Muñoz et al., 2020).

The second part of the data analysis involved content analysis, which was conducted to address research question 3. Content analysis is a qualitative research method that uses content in terms of texts, images, or other materials to find the relationships, trends, and themes (Stemler, 2015). It allows researchers to understand the deeper meanings, conceptual patterns and development of ideas in a particular field (Erlingsson & Brysiewicz, 2017).

After the bibliometric data were extracted, VOSviewer was used to perform co-word and co-citation analyses, which resulted in the formation of clusters based on the strength of keyword and reference linkages. These clusters represent groups of related concepts or frequently co-occurring topics within the field of mathematics interest research. The thematic labels for each cluster were assigned by the author based on a careful review of the articles within each cluster, the most frequently appearing keywords and the patterns of citation. This interpretive process followed established bibliometric content analysis practices (Zupic & Čater, 2015), ensuring that the thematic names accurately reflected the dominant ideas present in each cluster.

In this study, content analysis was applied to explore how the concept of mathematics interest had developed over time. The process involved grouping similar ideas and concepts into themes or clusters based on the content of selected studies. The studies were carefully read, interpreted, and categorized to uncover the main theories, research methods, key findings, and gaps in the literature.

This analysis showed how the topic of mathematics interest had been studied over the years. It helped to highlight changes in focus, new trends and areas that still need more research. When combined with bibliometric analysis, content analysis gave a different but helpful view by adding deeper understanding to the numbers and patterns. Together, these methods offered a comprehensive understanding of the research landscape and helped identify future research opportunities.

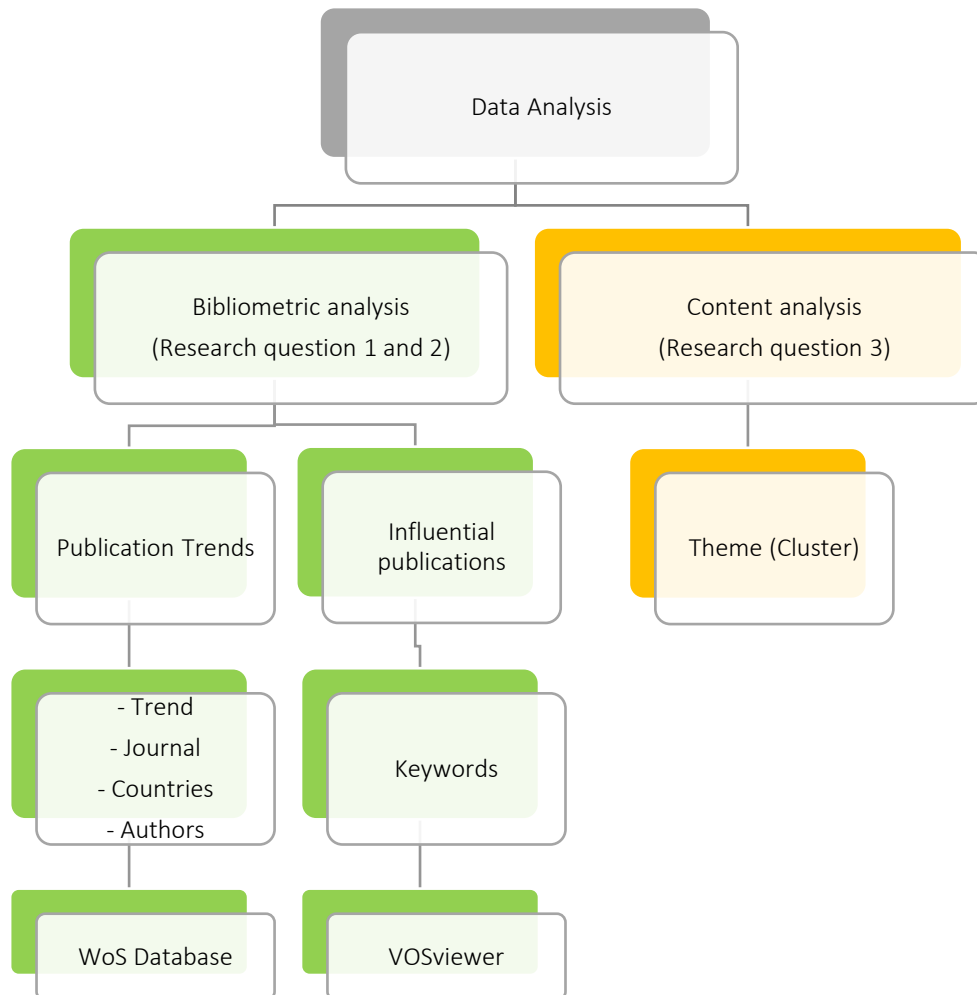


Figure 1. Analysis process (source: Ismail et al. 2024)

4. Results

This section presents the results of analysis using VOSviewer for: (1) yearly productivity for the period of 2021-2025, (2) number of articles published in the different journals indexed in Web of Science (WoS) database, (3) authors, (4) publication from different countries, (5) keywords and (6) Co-citation and (7) Content analysis.

RQ1: How has scholarly output on mathematics interest evolved between 2021 and 2025, and which journals, authors, and countries have contributed most to its development?

4.1. Analysis of yearly productivity

Figure 2 presents the annual publication productivity over the period of 2021–2025, indicating a sustained and growing scholarly interest in the study of students' mathematics interest. A total of 640 articles were identified in this five-year period. The data indicates a clear upward trend in scholarly productivity from 2021 to 2024, with a slight decline in 2025 likely due to partial-year data collection. In 2021, 88 articles were published, productivity increased steadily in 2022 and 2023. The peak was reached in 2024, with 198 articles published, the highest share in the five-year span. A drop

is noted in 2025, with only 57 articles, likely because the year is ongoing at the time of analysis. This trend suggests that research interest in mathematics related topics has grown significantly over the past few years, especially during and after the global pandemic years, when educational challenges and interest-based learning gained prominence.

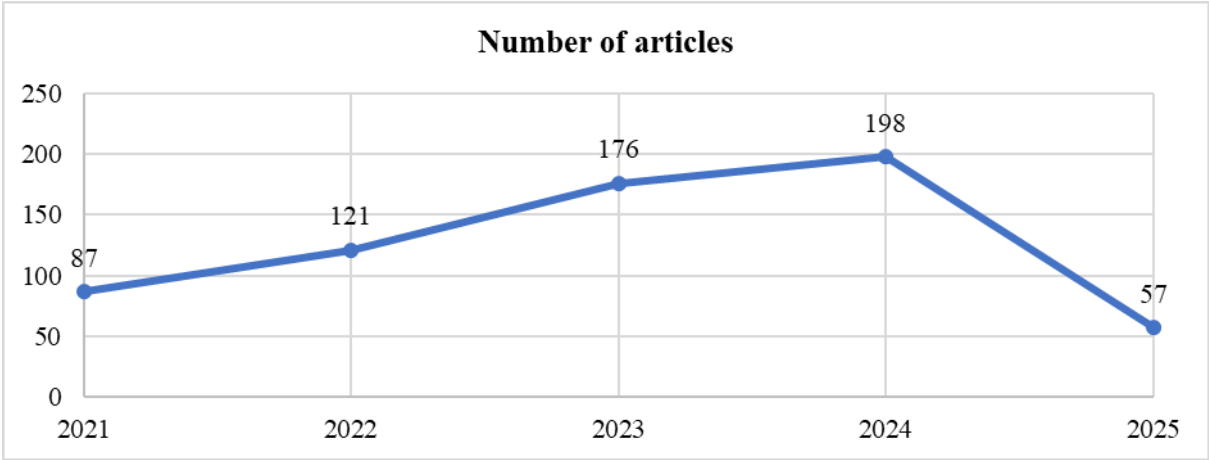


Figure 2. Yearly distribution trends from 2021 through 2025

4.2. Analysis of journals of publications

Table 3 shows the ten most active journals publishing research related to students' interest and performance in mathematics, arranged in descending order. Frontiers in Psychology leads with the highest number of publications (40 articles), reflecting its multidisciplinary focus and openness to educational psychology research. This is followed by Learning and Individual Differences (22 articles), Contemporary Educational Psychology (20 articles) and the European Journal of Psychology of Education (18 articles). Several other journals, such as Education Sciences, Frontiers in Education, Journal of Educational Psychology, and Social Psychology of Education, each contributed between 14 and 17 publications.

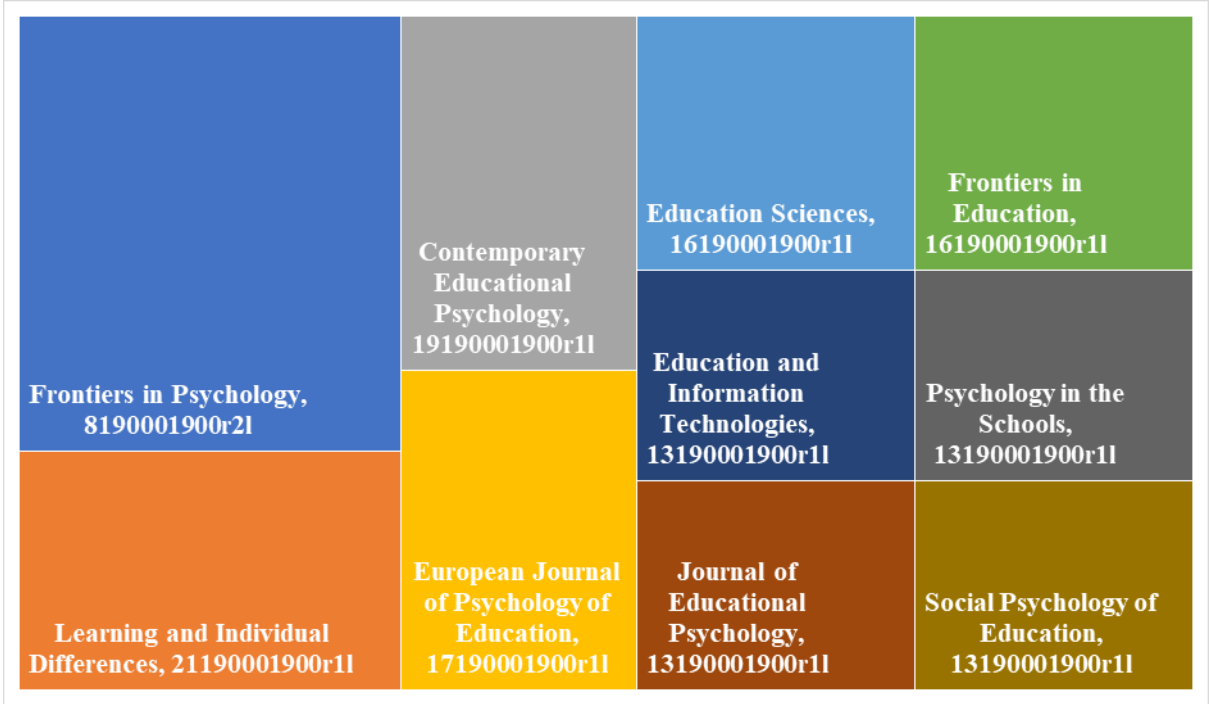


Figure 3. Number of publications by journals

4.3. Analysis of authors

Table 3 shows the most prominent author, ranked by the number of published works in the field of mathematics interest research between 2021 and 2025. Jianzhong Xu leads with the highest publication count, contributing 8 articles, indicating significant engagement in this research area. Alexandre J.S. Morin follows with 6 publications, reflecting sustained scholarly output. A group of authors, including Meng Guo, Jinqing Liu, Andrew J. Martin, Elizabeth Olivier, and Yuanhua Wang, have each contributed 5 articles, highlighting their consistent presence in the field. Additionally, Isabelle Archambault, Mimi Bong and Juan Del Toro each authored 4 publications, positioning them as influential contributors.

Table 2. Ten most Leading authors

Leading Authors	Record Count
Jianzhong Xu	8
Alexandre J.S. Morin	6
Meng Guo	5
Jinqing Liu	5
Andrew J. Martin	5
Elizabeth Olivier	5
Yuanhua Wang	5
Isabelle Archambault	4
Mimi Bong	4
Juan Del Toro	4

4.4. Analysis of countries

This study identified 87 countries out of which 35 countries met the threshold of producing a minimum of five journal articles. Table 4 presents the number of publications and citations by country. The top five countries are: (1) United States of America (179 journal articles), (2) China (124 journal articles), (3) Germany (56 journal articles), (4) England (31 journal articles) and (5) Australia (36 journal articles) in the area of mathematics interest and performance. Other countries such as Canada, the Netherlands and Finland demonstrate moderate influence. Emerging contributors like Malaysia, South Korea and Singapore are also represented, indicating growing research interest in this topic within Asian regions.

Table 4. Number of publications and citations by countries

Name of country	Documents	Number of citations
USA	179	1043
China	124	772
Germany	56	354
England	31	250
Australia	36	392
Canada	28	204
Netherlands	18	141
Switzerland	11	43

Name of country	Documents	Number of citations
Austria	7	29
Finland	19	101
Malaysia	14	56
South Korea	14	48
Norway	6	30
Singapore	8	53
South Africa	10	15

RQ2: What are the dominant and emerging themes in mathematics interest research based on keyword co-occurrence and network analysis from 2021 to 2025?

4.5. Analysis of keywords

This analysis focused on keywords that appeared most frequently in publications from 2021 to 2025. Using VOSviewer and a thesaurus method, 2,729 keywords were identified. Of these, 229 met the minimum threshold of appearing at least five times, as shown in Table 5. According to Sampagnaro (2023), the repetition of author keywords in academic articles reflects a journal's thematic concentration and specialisation. Frequent keyword analysis is an important bibliometric method used to track how research topics develop, find new trends and understand the main ideas in a scientific field (Zupic & Čater, 2015).

The keyword "achievement" emerged as the most frequently used term, appearing in 416 publications, highlighting its centrality in mathematics interest literature. Other commonly cited keywords include "motivation" (265 times) and "mathematics" (250 times), which suggests a strong emphasis on psychological factors and academic settings. Keywords such as "performance" (224 times) and "engagement" (124 times) also show a sustained research focus on student outcomes and involvement. The presence of terms like "self-efficacy" (99 times) and "beliefs" (64 times) indicates a considerable interest in students' perceptions and confidence in their mathematical abilities. In addition, context-related terms such as "gender", "school" and "adolescence" highlight the influence of demographic and environmental factors on students' interest in mathematics.

Table 5. Keywords

Keywords	Occurrence
Achievement	416
Motivation	265
Mathematics	250
Performance	224
Engagement	124
Student	108
Self-efficacy	99
Gender	68
Beliefs	64
Science	66
School	65
Adolescence	62

Figure 4 shows that “achievement” is the most prominent and centrally connected keyword, closely linked with terms like “performance”, “student” and “mathematics achievement”. This highlights the strong relationship between students’ interest in mathematics and their academic success. The keyword network also connects “achievement” with “gender”, “self-concept” and “expectancy-value theory”, reflecting an interest in motivational and psychological factors that influence learning outcomes (Eccles, 2009).

Another significant cluster includes terms such as “math anxiety”, “self-regulation” and “skills”, indicating research reflecting research into emotional and cognitive factors affecting students’ math performance and engagement (Ng et al., 2022). Keywords like “elementary school”, “high school” and “higher education” suggest that mathematics interest is studied across various educational levels. Furthermore, the presence of terms like “technology”, “STEM education” and “strategies” points to the role of instructional methods and digital tools in promoting mathematics interest and enhancing learning experiences (Khalid et al., 2025).

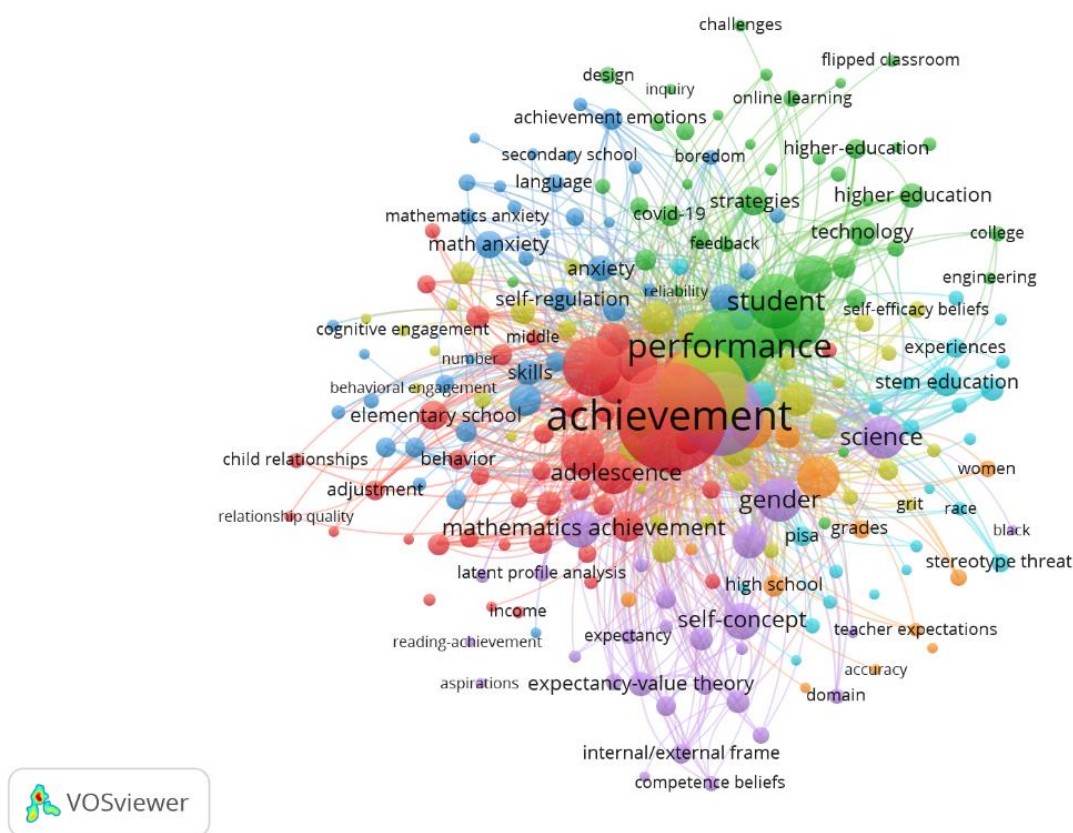


Figure 2. The keyword co-occurrence network on mathematics interest (visualised using VOSviewer)

4.6. Co-citation and Content analysis

Using VOSviewer, a co-citation analysis of 47 articles revealed five main thematic clusters. As shown in Table 6, Cluster 1 contains 14 articles, Cluster 2 has 12 articles, Cluster 3 includes 12 articles, Cluster 4 has 5 articles and Cluster 5 consists of 4 articles. Each cluster shows a different topic or focus in the research area. These clusters help us understand how the studies are connected and what themes are common in the literature. The table below lists each cluster and the articles that belong to them.

Table 6. Articles in each cluster

Cluster 1 (Motivation, Interest and Academic Performance in Mathematics)	Cluster 2 (Academic Self- Concept, Self- Efficacy and Expectancy-Value Theory)	Cluster 3 (Achievement Emotions and Their Impact on Learning and Performance)	Cluster 4 (Statistical Modeling and Measurement of Emotions in Education Research)	Cluster 5 (Growth Mindset, Beliefs About Intelligence and Gender Equity in Math Achievement)
Ames (1992)	Bandura (1977)	Bong and Skaalvik (2003)	Muthén and Muthén (1998)	Blackwell et al. (2007)
Duncan et al. (2007)	Bandura (2001)	Cheung and Rensvold (2002)	Pekrun et al. (2002)	Dweck and Leggett (1988)
Deci and Ryan (2000)	Bandura (1997)	Eccles (1983)	Pekrun (2006)	Else-Quest et al. (2010)
Fredricks et al. (2004)	Cohen (1988)	Eccles and Wigfield (2002)	Pekrun et al. (2011)	Yeager et al. (2019)
Hattie (2008)	Hair et al. (2010)	Eccles and Wigfield (2020)	Pekrun et al. (2017)	
Hu and Bentler (1999)	Honicke and Broadbent (2016)	Jacobs et al. (2002)		
Kline (2016)	Pintrich and De Groot (1990)	Marsh et al. (2005)		
Roorda et al. (2011)	Pintrich et al. (1993)	Marsh and Martin (2011)		
Ryan and Deci (2000b)	Pintrich (2000)	Trautwein et al. (2012)		
Ryan and Deci (2000a)	Richardson et al. (2012)	Valentine et al. (2004)		
Ryan and Deci (2017)	Tabachnick and Fidell (2019)	Wigfield and Eccles (2000)		
Ryan and Deci (2020)	and Zimmerman (2008)	Wigfield and Cambria (2010)		
Sirin (2005)				
Voyer and Voyer (2014)				

RQ3: What is the intellectual structure of mathematics interest research as revealed through co-citation analysis and thematic content analysis between 2021 and 2025?

The field of mathematics interest has evolved between 2021 and 2025. A co-citation analysis of research articles within this domain provides valuable insights into key focus areas, research trends and influential works. This helps deepen our understanding of how the interest in mathematics is studied within mathematics education. The formation of clusters reveals how the literature is organized into different topics or themes, offering a clear picture of the main areas being explored. In addition, these clusters help guide researchers to important sources in each area, making it easier to review existing work and identify gaps for future research.

4.6.1. Cluster 1 (Motivation, Interest and Academic Performance in Mathematics)

Cluster 1 consists of 14 documents that focus on how students' motivation and learning are shaped by their environment, personal needs and relationships. A number of these studies are

grounded in Self-Determination Theory (SDT), which explains that students are more motivated and perform better when their basic psychological needs for autonomy, competence and relatedness are supported (Ryan & Deci, 2000a, 2017, 2020).

Motivation comes in many ways. According to Ryan and Deci (2000a), the kinds of goals students pursue can affect their motivation and overall well-being. This is supported by Ames (1992), who emphasized that classroom structures promote either mastery-oriented goals (focus on learning) or performance goals (focused on comparison with others). Another important theme in this cluster is student engagement, which includes how students behave, feel, and think in school settings (Fredricks et al., 2004). A strong and positive teacher-student relationships also have a big impact on student engagement and achievement (Roorda et al., 2011).

Several studies in this cluster also examine background factors that influence academic achievement. Duncan et al. (2007) found that early math and reading skills are strong predictors of later academic success. Socioeconomic status (SES) also plays a major role, with Sirin (2005) showing that students from higher SES backgrounds tend to achieve better outcomes. In addition, Voyer and Voyer (2014) found that female students consistently outperform males in school grades across various subjects.

4.6.2 Cluster 2 (The Influence of Self-Efficacy and Self-Regulation on Academic Growth)

Cluster 2 includes 14 documents that focus on foundational theories and research on how students' beliefs about themselves affect their learning and performance. One of the most studied concepts in this cluster is self-efficacy, which refers to a person's belief in their ability to succeed in specific tasks (Bandura, 1977, 1997, 2001). This belief plays an important role in shaping students' motivation, learning behaviour and persistence, especially when facing challenges. Studies by Pintrich (2000), Pintrich et al. (1993) and Pintrich and De Groot (1990) explored how motivation and self-regulation are linked to academic outcomes. His research shows that students with high self-efficacy tend to use better learning strategies, which helps them perform better in school.

Similarly, Honicke and Broadbent (2016) systematic review showing a correlation between academic self-efficacy and academic achievement. Richardson et al. (2012) also highlighted the role of self-efficacy and goal setting as important factors for university performance. Zimmerman (2008) also emphasized the importance of self-regulated learning, which involves students managing their own learning process through setting goals, planning, monitoring and evaluating their progress. These studies support the idea that building students' confidence and encouraging independent learning strategies can lead to better academic outcomes.

In terms of research methodology, many studies use tools such as the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1993) and refer to standard statistical references such as Cohen (1988) for effect sizes and Hair et al. (2010) and Tabachnick and Fidell (2019) for multivariate analysis. These tools indicate the cluster's strong focus on analysing the complex relationships between cognitive, motivational and achievement-related variables.

4.6.3. Cluster 3 (Self-Beliefs and Expectancy-Value Motivation in Student Achievement)

Cluster 3 includes 12 documents that focus on the influence of students' self-belief and motivation towards their learning and performance in school. The Expectancy-Value Theory (EVT) developed by Eccles and Wigfield, explains that students believe they are able to do well when they assume the task is important for them (Eccles & Wigfield, 2002; Wigfield & Cambria, 2010; Wigfield & Eccles, 2000). Later research by Eccles and Wigfield (2020) expanded the EVT by emphasizing the influence of cultural context, social messages, and perceived costs such as stress, effort, and time investment on students' motivation. Trautwein et al. (2012) tested the theory and found that

students performed best when they had both high confidence in their abilities and placed high value on the task.

Research shows that self-concept and self-efficacy are about how confident students feel in their abilities, but they are slightly different. Self-efficacy is more focused on what students think they can do in a specific situation, while self-concept is a broader view of their abilities over time (Bong & Skaalvik, 2003). Studies also show that students' confidence and beliefs about their abilities change as they grow older. A longitudinal study by Jacobs et al. (2002) shows that students' self-beliefs in mathematics often decrease as they move through schools during their teenage years. This drop in self-belief leads to lower interest in mathematics. Even small improvements in self-beliefs can lead to better results in the classroom (Valentine et al., 2004). Therefore, it is important for students to have a positive academic self-concept to get better academic performance. Marsh et al. (2005) also found that when students have higher self-concept, it helps increase their interest and test scores later on. Meanwhile, to get accurate findings across different groups of students, latent modelling and tests for measurement invariance have been used (Cheung & Rensvold, 2002). Scholars often use strong measurement tools and statistical methods to get the relationship.

4.6.4. Cluster 4 (Understanding and Measuring Emotions in Educational Settings)

Cluster 4 includes 5 documents that focus on the importance of emotions in students' academic life. Emotions like enjoyment, anxiety, boredom and pride influence students' learning motivation and performance in school (Pekrun, 2006; Pekrun et al., 2002). Educational research has been focused mainly on test anxiety, but limited studies focus on emotional occurrences in classrooms such as hope, relief, anger and even shame (Pekrun et al., 2002). Therefore, to better understand students' emotions, the Academic Emotions Questionnaire (AEQ) was developed to measure different types of emotions that are experienced in various learning situations (Pekrun et al., 2011). AEQ is a reliable and valid tool that helps teachers and researchers explore how emotions are linked to learning outcomes. (Pekrun et al., 2017) used structural equation modelling to show that students who experience positive emotions such as pride and enjoyment tend to perform better in school. In contrast, those who experience negative emotions such as anxiety and hopelessness often achieve lower results.

Another important focus on this cluster is about control-value theory, which suggests that students' emotions are influenced by how much control they feel over a task and how much they value its outcome (Pekrun, 2006). This theory has helped researchers understand emotions and achievement influence each other in both directions. Good results can boost positive emotions, while repeated struggles increase negative ones (Pekrun et al., 2017).

4.6.5. Cluster 5 (Growth Mindset, Beliefs About Intelligence, and Gender Equity in Math Achievement)

Cluster 5 includes 4 documents that focus on students' beliefs about intelligence and mindsets that influence their learning and performance, especially in mathematics. Research by Dweck and Leggett (1988) introduced the idea that some students see intelligence as a growth mindset while others believe it is fixed. Students with a growth mindset tend to keep trying and learn from mistakes. Those with a fixed mindset may give up easily if they don't succeed right away. Blackwell et al. (2007) found that students who believe intelligence could be developed did better in math over time. In fact, when students were taught that their brains could grow through effort, they became more motivated and their grades improved. Those who didn't receive the mindset training continued to show a drop in their performance.

Following these findings, Yeager et al. (2019) tested a short online growth mindset intervention with a large number of students across the United States. They found that lower-achieving students

who received the mindset message improved their grades and were more likely to take advanced math classes. The results also showed that mindset interventions work best in school environments that support and reinforce the same ideas. In addition, to beliefs about intelligence, researchers are also interested in how gender impacts math learning. Else-Quest et al. (2010) analysed data from nearly 500,000 students in 69 countries and found that boys and girls perform similarly in math. However, boys often report feeling more confident and positive about the subject. Importantly, the study found that countries with more gender equality had smaller gaps in math attitudes and achievement.

5. Discussion

Mathematics interest is an important component of learning because it increases students' motivation and improves their achievement (Lee et al., 2014; Schukajlow et al., 2023). This bibliometric content analysis, conducted through co-citation and thematic review, provides a holistic overview of mathematics interest in education from 2021 to 2025. By looking at main research topics, popular theories, and key studies, this review shows important trends, shifts in research focus, and existing gaps in the literature. The findings of this study not only improve our understanding of how mathematical interest is defined and explored, but also offer important insights for teachers, curriculum planners, and education policymakers. In particular, the analysis shows the importance of considering students' motivation, emotions and social influences to help them stay interested in mathematics over time.

In addition to thematic trends, the bibliometric analysis provides insights into research productivity and influence across journals and countries. Recent trends in mathematics education research reflect growing recognition of interest as a key motivational factor, especially in response to post-pandemic challenges in student engagement (Schukajlow et al., 2023). Leading publication outlets included *Frontiers in Psychology*, *Learning and Individual Differences* and *Contemporary Educational Psychology*, which are known for publishing research on affective and cognitive variables related to mathematics learning (Hui & Mahmud, 2023; Schukajlow et al., 2023). The United States leads in publication output, followed by China, Germany, Australia and England. These countries have long-established educational research infrastructures that support large-scale studies in motivation and mathematics performance (Navarro-Ibarra et al., 2025; Yang et al., 2025).

One key observation from the analysis is how research on mathematics interest has developed over time. Earlier studies (Cluster 1) focused mainly on student motivation and engagement. These studies looked at how academic development is influenced by social conditions and the fulfilment of psychological needs such as autonomy, competence and relatedness (Fredricks et al., 2004; Ryan & Deci, 2000b). These ideas formed the foundation for later research. Over time, researchers began studying more specific ideas like self-efficacy and self-regulated learning (Cluster 2), which explain how students' confidence (Bandura, 1997) and learning strategies (Zimmerman, 2008) affect their motivation and performance.

Later studies expanded to include expectancy-value theory and academic self-concept (Cluster 3), focusing on how students' beliefs about the value of tasks, the effort required and their own abilities influence their learning (Eccles & Wigfield, 2002; Marsh et al., 2005). More recent research explored students' emotions in learning (Cluster 4), showing that feelings such as anxiety, pride, or enjoyment can strongly affect how students learn mathematics (Pekrun, 2006). Finally, researchers have also started to look at social and cultural factors, such as beliefs about intelligence and gender differences in math achievement (Cluster 5). These studies show that mindset training and fair learning environments can help more students develop interest in mathematics (Dweck & Leggett, 1988; Yeager et al., 2019).

Even though much research has been done on mathematics interest, important gaps still remain. One important gap is the limited number of cross-cultural and intervention-based studies exploring the long-term patterns of students' mathematics interest. While many studies explore short-term effects, less is known about how early interest in mathematics can be sustained throughout secondary and post-secondary education. Future research should investigate the long-term impact of interventions aimed at fostering interest, especially across key transition points in students' academic journeys. Additionally, while motivation, emotion and social context are increasingly studied, there is limited integration of these dimensions in a unified framework. More interdisciplinary research is needed to understand how these factors interact in real classroom settings.

6. Conclusion

This study explored the landscape of research on mathematics interest by integrating bibliometric analysis and systematic review methods. A total of 639 articles retrieved from the Web of Science (WoS) database between 2021 and 2025 were analysed to uncover publication trends, influential authors, key themes and research gaps in the field. The bibliometric analysis revealed a growing interest in the topic, with a noticeable increase in publications over the years. Frequently occurring keywords such as achievement, motivation, performance and self-efficacy indicate a strong focus on psychological and educational outcomes. Influential authors, journals and countries were identified, highlighting collaborative networks and global contributions to the field.

The content analysis complemented these findings by organising the literature into thematic clusters, providing deeper insights into how mathematics interest has been conceptualised and studied. Key theories, methodologies and areas of focus were identified, along with emerging trends and underexplored topics. Together, the dual approach of bibliometric and content analysis provided a comprehensive overview of the research landscape. The findings underscore the central role of mathematics interest in learning and academic performance and suggest future research should continue to explore its interaction with psychosocial factors, instructional strategies and contextual variables. This study contributes to a better understanding of the structure and evolution of research on mathematics interest and offers a foundation for scholars, educators, and policymakers seeking to design more effective interventions and curricula that foster student engagement and success in mathematics.

7. Limitations and suggestions for future research

This study offers valuable insights into the structure and trends of mathematics interest research. However, several limitations should be acknowledged. First, the analysis was limited to articles indexed in the Web of Science (WoS) database, which may have excluded relevant publications from other sources. Although WoS is a reputable and widely used source for bibliometric research (Mongeon & Paul-Hus, 2016), relying solely on this database may have narrowed the diversity and comprehensiveness of the dataset. Notably, excluding databases such as Scopus, ERIC, or Google Scholar may have resulted in the omission of important regional or interdisciplinary studies. Future research could benefit from incorporating multiple databases to capture a broader and more representative range of research outputs.

Additionally, only English-language articles were considered to overlook significant research conducted and published in other languages, particularly from non-English-speaking regions. The study also focused on a relatively short time frame (2021–2025), which may not fully capture historical trends or foundational work in the field. Furthermore, the keyword analysis was based primarily on author-supplied keywords, which may vary in specificity and consistency, potentially affecting the accuracy of thematic clustering. Lastly, although efforts were made to ensure objective

content analysis, some degree of subjectivity may have affected how the themes were grouped and understood.

For future research, expanding the data sources to include multiple databases could provide a more comprehensive and balanced overview of the literature. Longitudinal studies covering a wider range of years would help track the evolution of key concepts over time. Including non-English publications and exploring regional or country-specific studies would add cultural depth and global perspective to the analysis. Future work could also apply deeper qualitative techniques, such as meta-synthesis or grounded theory, to enhance thematic understanding. Finally, research should investigate how findings on mathematics interest are applied in real-world contexts, such as curriculum design, teaching strategies and educational policy.

Declarations

Author Contributions. VS, SMM, & MSM: conceptualization, validation, & writing—review & editing; VS: software, visualization, & writing—original draft; & SMM & MSM: methodology & supervision. All authors have agreed with the results and conclusions.

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Data Availability Statement. No new data were generated

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