MODESTUM EURASIA Journal of Mathematics, Science and Technology Education, 2024, 20(10), em2513
ISSN:1305-8223 (online)
OPEN ACCESS Review Article https://doi.org/10.29333/ejmste/15179

Parental involvement in students' mathematics activities: A bibliometric analysis

Achmad Salido [1,2*], Sugiman [3], Puji Yanti Fauziah [4], Aufal Kausar [1], Safril Haskin [5], M. Azhar [6]

[1] Department of Primary Education Doctoral, Universitas Negeri Yogyakarta, Yogyakarta, INDONESIA
[2] Department of Mathematics Education, Universitas Sembilanbelas November Kolaka, Kolaka, INDONESIA
[3] Department of Mathematics Education, Universitas Negeri Yogyakarta, Yogyakarta, INDONESIA
[4] Department of Non-Formal Education, Universitas Negeri Yogyakarta, Yogyakarta, INDONESIA
[5] Department of Primary Education Magister, Universitas Negeri Yogyakarta, Yogyakarta, INDONESIA
[6] Department of Educational Technology Magister, Universitas Negeri Yogyakarta, Yogyakarta, INDONESIA

Received 22 June 2024 ▪ Accepted 28 August 2024

Abstract

This study is focused on investigating parental involvement in students' mathematical activities. It presents a comprehensive bibliometric analysis that examines new areas of research to discover current trends and future research opportunities related to parental involvement in their children's mathematics activities. This study intends to provide a meaningful contribution toward enhancing educational interventions in the future. The metadata of the publications included in this analysis was extracted from the Scopus and ERIC databases using the search criteria "(parent OR parent) AND (involvement OR support) AND (math or math) AND student." After the screening step, a comprehensive analysis was conducted on a total of 944 articles using the tools Harzing's Publish or Perish 8, Biblioshiny, and VOSviewer 1.6.20. The findings indicated that studies on this topic covered 42 years and accumulated a total of 17,392 citations. The most prolific year in terms of publications was 2023, with a peak of 80 studies published. The leading contributors to this body of research were Jianzhong Xu and James Reed Campbell, each authoring six papers. The keyword mapping results revealed several interesting research avenues for future investigation, such as the incorporation of psychological interventions, longitudinal studies, multidisciplinary approaches, and the utilization of technology.

Keywords: parental involvement, mathematics, students, bibliometric

INTRODUCTION

Parental involvement in their children's education has been extensively explored in educational research. Numerous studies indicate that parental participation can significantly impact children's academic outcomes, particularly in mathematics. Various aspects of parental involvement influence children's mathematical achievement differently (Huang et al., 2021). The way parents participate in their children's mathematics learning activities can impact how the kids view math. Children's confidence and drive to learn have been found to grow with positive involvement, which includes academic monitoring, moral support, and help with schoolwork (Rodríguez et al., 2017; Silinskas & Kikas, 2019). Children tend to feel more confident, have higher motivation and discipline, and are encouraged to learn mathematics more effectively when their parents are involved in the process (Purnomo et al., 2021; Rodríguez et al., 2017; Shukla et al., 2015; Wu et al., 2022). Support from parents has also been found to help lessen the dread and worry that kids frequently feel when learning math (Choi & Han, 2020; Vukovic et al., 2013).

Parental anxiety about mathematics has a negative impact on children's attitudes and performance and may prevent them from accepting math challenges (Bellon et

✉ achmadsalido.2022@student.uny.ac.id **(*Correspondence)** ✉ sugiman@uny.ac.id ✉ pujiyanti@uny.ac.id
✉ aufalkausar.2020@student.uny.ac.id ✉ safrilhaskin.2022@student.uny.ac.id ✉ mazhar.2022@student.uny.ac.id

Contribution to the literature

- The primary data sources for this literature are carefully obtained from the ERIC and Scopus databases.
- The report presents an analysis of the current state of parental intervention in students' future math activities, including the landscape, significant research trends, and recommendations for future research areas.
- The study has identified the most prominent authors, works, and journals that have had the most significant influence on research trends regarding parental participation in children's mathematical activities.

al., 2022). Children's perceptions and involvement with mathematics studies may be negatively impacted by this worry, which may spread unfavorable views toward the topic (Bellon et al., 2022; Soni & Kumari, 2017). As a result, parents must encourage their kids to learn mathematics in a pleasant atmosphere (Jay et al., 2018). Parents can assist their children in managing math anxiety and enhancing their learning engagement by providing appropriate guidance and cultivating a good attitude toward math (Serin, 2023). Collaboration between parents and children in tackling math challenges can lead to improved academic performance and the development of more vital math skills (Møller & Kaup, 2023; Sheldon & Epstein, 2005).

Numerous scholarly investigations have underscored the noteworthy influence of parental participation on offspring's mathematical education. Yaro (2015) discovered that, in Ghana, parents with less formal education had a significant influence on their children's mathematics education by providing learning settings such as local business counsel and transactions. Ing (2014) highlights how parents' motivational strategies affect their kids' mathematic proficiency and persistence in STEM fields. Parents can improve their children's math development in several ways, such as by giving them learning resources, offering to help with homework, and modeling good study habits (Kyeremeh & Dorwu, 2022). Ashton et al. (2011) emphasize that to effectively support parents in helping their children develop their mathematic skills, it is critical to comprehend their motives and views. Silinskas and Kikas (2019) explored the relationship between parental involvement in math homework and children's performance and motivation, finding that children who felt insecure in math experienced more parental control, which was linked to poorer math results, lack of perseverance, and low confidence in math. These studies collectively highlight the varied nature of parental involvement in children's math education and the need for tailored support strategies.

The diversity of studies conducted has introduced a bias in the research area concerning parental involvement in children's mathematics activities, highlighting the need for future research opportunities. Additionally, there has been no research that comprehensively explores the existing literature to understand research trends and opportunities in this field based on the explored database. Holistic research on trends and opportunities in this area will provide valuable insights, forming a foundation for improving future educational interventions. Consequently, this bibliometric analysis aims to examine the latest research trends and potential avenues for further investigation regarding parental involvement in children's mathematics activities. This study is expected to make a significant contribution to the future development of mathematics education by addressing two main questions:

1. What is the overall landscape and publication trend regarding parental involvement in students' math activities?
2. What opportunities exist for future investigations into parental involvement in students' math activities?

LITERATURE REVIEW

Parental involvement in their children's education is a crucial determinant of their academic achievement, encompassing diverse modes of involvement (Kantova, 2024; Sachdeva, 2023). Parents who actively support their children's learning contribute to establishing a favorable learning environment and enhance their children's motivation to learn (Coulombe, 1995). This engagement can manifest in several ways, such as actively participating in school events, maintaining regular connections with teachers, and providing support for learning at home (Averill et al., 2016; Coulombe, 1995). Participation in this manner is particularly crucial for children from diverse backgrounds, as it can facilitate the connection between their home and school environments (Averill et al., 2016). Thus, it is imperative to cultivate robust collaborations across schools, families, and communities to ensure a child's achievement (Đurišić & Bunijevac, 2017).

Within the context of mathematics education, parental involvement can take on different manifestations, such as assisting with homework, fostering a nurturing home atmosphere, expressing gratitude for children's endeavors, and commemorating their accomplishments (Goshin & Mertsalova, 2018;

Hernández-Padilla et al., 2023). Children's attitudes and academic achievement are significantly influenced by family dynamics (Soni & Kumari, 2017). Parents can assist their children in completing mathematical assignments by offering direction while solving intricate issues or by elucidating challenging concepts that may be difficult for children to comprehend. In addition, parents can demonstrate their recognition and admiration for their children's endeavors and accomplishments in mathematics classes, thus fostering a sense of motivation for the children to persist in their learning and enhance their skills (Hernández-Padilla et al., 2023). Increased parental support is crucial for children to develop their math abilities (Silinskas & Kikas, 2019). Parental support is advantageous for students' academic motivation as it fosters the development of a child's autonomy and competence by providing opportunities for decision-making and active engagement in problem-solving (Wu et al., 2022). Nevertheless, the efficacy of these interactions is contingent upon variables such as parents' educational attainment, social situation, and cultural background (Cui et al., 2021; Goshin & Mertsalova, 2018).

Proficiency in mathematics, exhibited by both parents and children, can enhance the quality of their mathematical interactions (DiStefano et al., 2023). Parental involvement, including their perspective on and appreciation of mathematical performance and success, positively influences students' long-term motivation and achievement in math (Hong et al., 2010; McDonnall et al., 2012; Shukla et al., 2015). Furthermore, there is a positive correlation between the involvement of parents and children in mathematics activities and the children's comprehension of the subject being taught (Yang et al., 2023). It is crucial to remember that varying degrees of parental involvement can have distinct impacts on children's mathematical aptitude (Huang et al., 2021). Zhou et al. (2022) found that increased parental support is linked to reduced mathematic anxiety and improved math achievement in youngsters. Parents' positive attitudes towards mathematics also benefit pupils' apprehension towards mathematics, so offering insights into how to engage parents in therapies targeting math anxiety (Choi & Han, 2020).

METHODOLOGY

This study employs a bibliometric analysis approach to explore the extent of research on parental involvement in children's mathematical activities from the inception of publishing to 2024. Bibliometric analysis is a commonly employed method for examining extensive sets of scientific data (Block & Fisch, 2020; Donthu et al., 2021). This study utilizes the Scopus and ERIC databases as data sources, which were examined on 4 June 2024. The utilization of the two databases is predicated on the convenience of conducting searches, arranging, and gathering metadata as the primary data for this study.

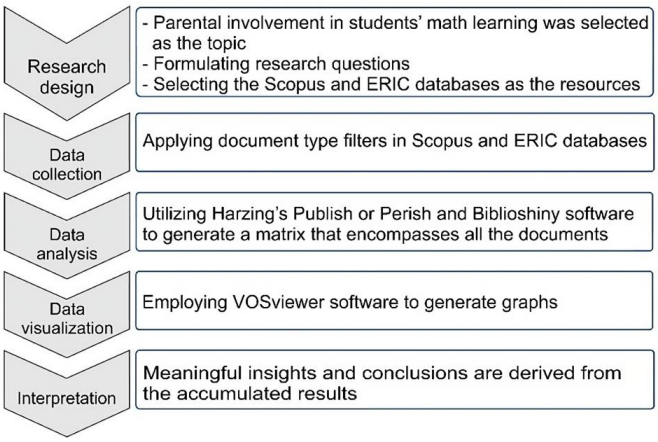

Figure 1. Investigation procedure (Adapted and elaborated by the authors from the work of Zhu et al., 2023)

The search words "(parent OR parental) AND (involvement OR support) AND (math or mathematic) AND student" are utilized to conduct a comprehensive investigation of the level of parental involvement in math education. The results of this analysis are expected to be utilized as a reference for future research on parental involvement in their children's mathematics activities.

The investigative process outlined in this study consists of five distinct stages: research design, data collection, data analysis, data visualization, and data interpretation, as depicted in **Figure 1** (Secinaro et al., 2020; Zhu et al., 2023; Zupic & Čater, 2015). The research design stage encompasses several key components: selecting the theme of parental involvement in student mathematics learning as the central focus of the research; formulating research questions that provide an overview of citation metrics, research trends, and potential avenues for future studies; and identifying the Scopus and ERIC databases as the primary sources for gathering information. During data collection, 747 documents were identified in the Scopus database, and 2,553 articles in the ERIC database. The screening in the Scopus database involved identifying articles based solely on their document type, resulting in a total of 556 articles being collected. In addition, the screening in the ERIC database was conducted by filtering for publications that had undergone peer review and were of the specified document type, and a total of 622 articles were obtained. A total of 1,178 articles were retrieved from the screening process by combining data from Scopus and ERIC. In addition, duplication screening was conducted with the assistance of MS Excel, resulting in the identification of 234 duplicate papers. The total number of documents used in this study is 944. This screening method aims to streamline peer-reviewed scientific communication, foster the generation of significant research inquiries, and enhance the precision of research findings (Kelly et al., 2014). The ultimate metadata of the filtering results is produced in research

information systems format as the primary data for utilization in the data analysis step.

Following the data collection stage, the subsequent phase in the study process entails examining and interpreting the collected data, known as data analysis. This stage aims to analyze the patterns of publication and citation metrics over time and generate a visual depiction of the data (Donthu et al., 2021). This analysis employs the tools Harzing's Publish or Perish 8, Biblioshiny, and VOSviewer 1.6.20. We utilize all three of these software products due to their open-source nature, which enables consumers to freely obtain them without incurring any expenses. The preliminary data analysis phase employs Biblioshiny, and Harzing's Publish or Perish programs to display publication patterns and citation metrics. Biblioshiny is utilized to visually represent the dissemination of publications about a specific issue, spanning from the inception to the present, using data from the database. Harzing's Publish or Perish software is utilized to present citation metrics according to the time of publishing. Furthermore, the research advances to the data visualization phase, in which the correlation between authors and keywords is depicted by network, overlay, and density visualization. The data visualization stage is conducted using the VOSviewer application. During the concluding phase of this study, we analyze the data to derive significance from the results gained through data analysis and visualization to address the research questions. Lastly, interpretation activities are conducted to derive conclusions from the findings gathered throughout the study.

RESULTS AND DISCUSSION

This section examines research themes and discoveries on parental involvement in their children's mathematical activities. The reported results and analysis encompass network analysis using data visualization, study of publishing trends, and citation metrics derived from metadata.

The Analysis of Publication Trends and Metrics Citation

Table 1 summarizes the publishing topics related to parental involvement in their children's mathematic activities based on citation metrics during the research period. **Table 1** provides a comprehensive analysis of parental involvement in children's mathematics activities. The study covers a period of 42 years, from 1982 to 2024, and utilizes data obtained from Scopus and ERIC databases. Throughout this time frame, a grand total of 944 articles were published, resulting in a cumulative sum of 17,392 noteworthy citations. The publication obtains an average of approximately 414.10 citations every year, indicating their notable recognition in the academic community. Furthermore, each scientific work garnered an average of 18.42 citations per piece, showcasing its impact and importance. The citation count per author was documented as 9,062.88, with an average of 481.39 publications per author. This information suggests the presence of a prolific or influential writer in this field. The average number of authors per manuscript is 2.76, indicating the extensive collaboration among specialists in the field of research.

Table 1. Citation metrics (the authors' elaboration using Publish or Perish 8)

Main information	Value
Publication years	1982-2024
Citation years	42 (1982-2024)
Papers	944
Citations	17,392
Cites/year	414.10
Cites/paper	18.42
Cites/author	9,062.88
Papers/author	481.39
Authors/paper	2.76
h-index	60
g-index	118
hI, norm	43
hI, annual	1.02
hA-index	14

The h-index of 60 signifies that at least 60 articles have each acquired a minimum of 60 citations. A G-index of 118 indicates that specific articles have received a significant number of citations, underscoring the significance of prominent works in shaping the discourse within the field. The norm index of hI, which is 43, and the hI annual, which is 1.02, provide vital insights into citations' long-lasting and evolving effects. Additionally, the hA-index, which measures the significance of citations from the initial publication up to the present, was documented as 14. These findings highlight the substantial impact of published research on the overall academic environment and underline the crucial role of frequently referenced publications in promoting the progress of academic knowledge and innovation in related domains. Furthermore, the evolution of scientific publications on parental involvement in children's mathematical activities during the study period is illustrated in **Figure 2**.

Figure 2 illustrates a trend of increasing publications on parental involvement in their children's math learning activities from 1982 to 2024. Initially, the number of publications per year was relatively low, with no publications recorded in 1984. From the 1990s, the number of publications gradually increased, with some minor fluctuations. A more noticeable rise occurred from the mid-2000s, with annual publications steadily growing, reaching about 20 articles per year by 2005. This upward trend continued consistently, peaking at 80 articles in 2023. In 2024, there is a decrease in the number

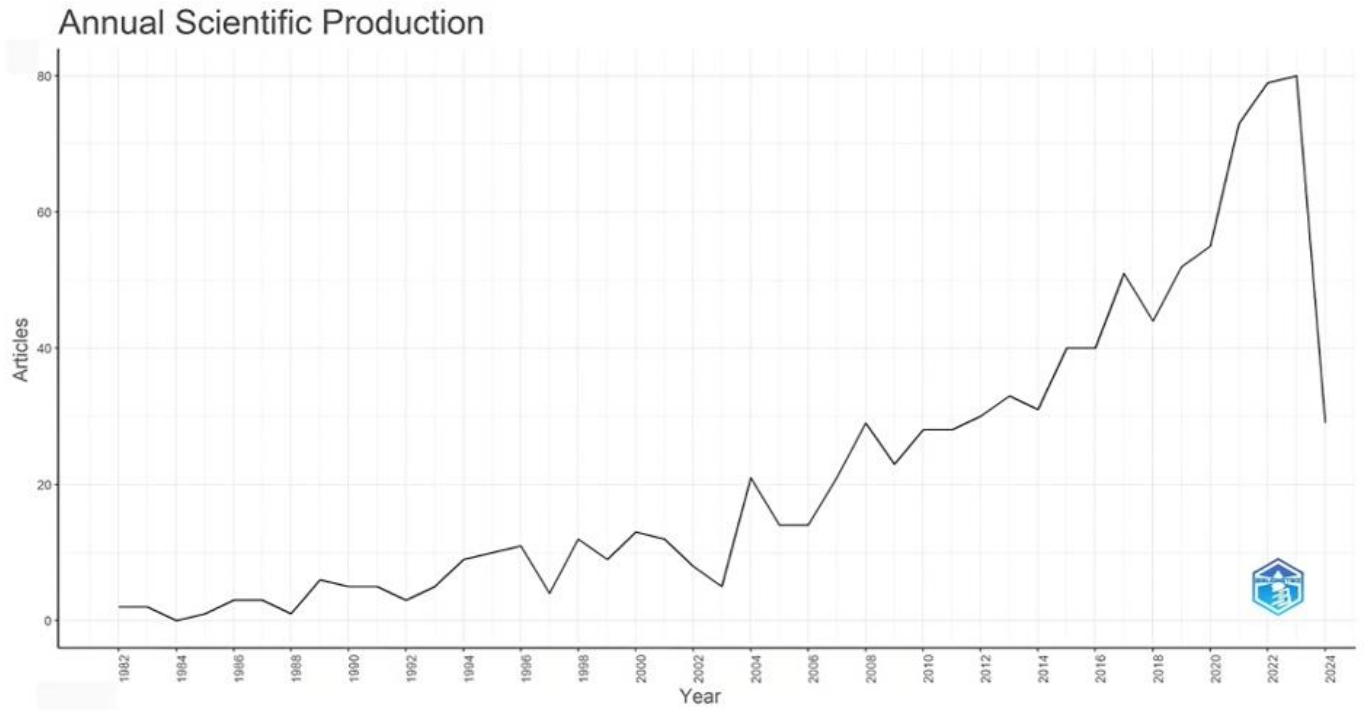

Figure 2. Distribution of publications (Source: Authors' own elaboration, using Biblioshiny)

Table 2. Top-five articles with the most citations (Source: The authors' elaboration using Publish or Perish 8)

Cites	C/Y	Authors	Year	Title	Source
1,574	68.43	Xitao Fan and Michael Chen	2001	Parental involvement and students' academic achievement: A meta-analysis	Educational Psychology Review
593	21.18	Esther Ho Sui-Chu and J. Douglas Willms	1996	Effects of parental involvement on eighth-grade achievement	Sociology of Education
496	18.37	Andrew J. Fuligni	1997	The academic achievement of adolescents from immigrant families: The roles of family background, attitudes, and behavior	Child Development
422	23.44	Carrie R. Leana and Frits K. Pil	2006	Social capital and organizational performance: Evidence from urban public schools	Organization Science
396	11.00	Camilla Persson Benbow	1988	Sex differences in mathematical reasoning ability in intellectually talented preadolescents: Their nature, effects, and possible causes	Behavioral and Brain Sciences

of publications, which can be attributed to incomplete data for that year.

The initial paper to tackle this topic was published in 1982. The exploration of parental involvement in mathematics activities began with the research conducted by Scheer and Henniger (1982). They studied the diagnostic mathematics clinic at Southern Illinois University, Carbondale, which aimed to assist students in overcoming math learning difficulties by engaging their parents in the educational process. In addition, Anderson (1982) investigates a rigorous junior high school instructional program implemented by the government that focuses on enhancing performance in reading and mathematics. The program highlights the significance of obtaining a signed parental agreement as crucial in increasing ninth-grade test scores. Recently, Kassis et al. (2024) conducted a study that explores the effects of the COVID-19 pandemic on the mental health of adolescents, specifically their levels of depression and anxiety, as well as their ability to adapt and succeed academically in high school. The study focuses on factors related to individual and social adaptation and the influence of parents. The results indicated a significant correlation between parental participation and academic achievement, with pupils with solid support from their parents demonstrating superior performance.

The five articles with the highest number of citations in a study on parental involvement in children's mathematics activities from 1982 to 2024 are shown in **Table 2**. These citation metrics include total citations (cites) and average citations per year (C/Y) for each article, as well as information on the author, year of publication, article title, and publication source

Table 2 revealed that the articles authored by Fan and Chen (2001) published in the journal Educational Psychology Review had the highest number of citations from 1988 to 2006. This article focused on conducting a meta-analytic review to explore the correlation between

parental involvement and student academic achievement. This article garnered a cumulative total of 1,574 citations, resulting in an average of 68.43 per year. Moreover, Sui-Chu and Willms (1996) conducted a study published in Sociology of Education. The study explores the various aspects of parental participation in promoting academic success among students, namely in reading and math achievement. This article contains 593 citations, averaging 21.18 citations per year. Fuligni (1997) subsequent work investigates the comparative influence of family history, parental views, peer support, and teenage attitudes and behaviors on the academic performance of students from immigrant homes. This paper was published in the journal Child Development and has received 496 citations. The average number of citations per year is 18.37. The paper by Leana and Pil (2006) investigates the correlation between social capital and academic performance in mathematics and reading among students. It ranks fourth in terms of citations, with a total of 422. This article was published in Organization Science and has an annual citation count of 23.44. Additionally, Benbow (1988) wrote the article that holds the fifth position and is the oldest. This article explores gender disparities in verbal and mathematical aptitude, focusing on analyzing their origins and causes. This article was published in the journal Behavioral and Brain Sciences and has garnered 396 citations, with an average annual citation rate of 11.00. The publications with the highest number of citations in these five areas have had the most significant impact on the development of this theme in academia, as determined by the collected database.

Data Visualization and Network Mapping for Analysis of Future Studies

These findings indicate that research on parental involvement in children's mathematics activities has engaged 2,375 authors. These authors were categorized into 775 clusters, with 3,572 links and a total link strength 3,664. The results of author mapping using VOSviewer, displaying authors with at least one publication, are illustrated in **Figure 3**.

Based on **Figure 3**, it is found that the authors with the five most publications are Jianzhong Xu and James Reed Campbell with six documents and Marta Civil, Xin Ma, and Sandra D. Simpkins with five documents. Each author has a different number of links between authors. These results show that the authors focus on the theme of parental involvement in children's math activities.

The keyword mapping results on the parental involvement in children's mathematics activities themes revealed 738 items out of 2,073 keywords and were arranged in seven clusters. The results of this keyword mapping based on network visualization are shown in **Figure 4**.

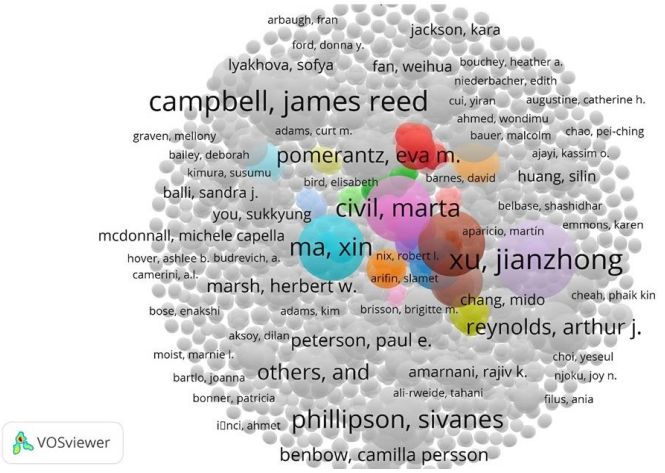

Figure 3. Network visualization of co-authorship (Source: Authors' own elaboration, using VOSviewer 1.6.20)

According to **Figure 4**, the authors commonly used keywords to represent their cluster regions are "foreign countries", "mathematics achievement", "human", "longitudinal studies", "gender differences", "self-determination", and "age differences". The red cluster links the keyword "foreign countries" with related terms such as "parent participation", "mathematics instruction", "elementary school mathematics", "student attitudes", "homework", "numeracy", and other relevant keywords. This cluster pertains to research that explicitly examines parental involvement within the context of mathematics education across various countries. Researchers in this cluster are emphasizing the impact of regional and cultural settings on parental participation and students' mathematics learning results. This finding is supported by the research of Atasoy et al. (2022), who examined the influence of information and communication technologies (ICT) use, parental support, and student barriers on science achievement in three countries, including Turkey, the USA, and South Korea, using PISA 2018 data. Kaya and Ok (2022) also investigated the challenges mathematics and science educators encounter in classrooms comprising Syrian pupils with temporary protection status, along with proposed remedies for these issues.

The keyword "mathematics achievement" is linked to other keywords such as "academic achievement", "parent school relationship", "program effectiveness", "elementary secondary education", "science achievement", and more within the green cluster. This cluster focuses on academic attainment in mathematics and explores the correlation between parents and educational institutions. This invention highlights the significance of parental involvement in students' academic success, as supported by Zhu and Chiu (2019) research. They found that engaging in early numeracy activities at home is connected to students' mathematics achievement. This connection is partly influenced by children's early numeracy skills and their belief in their

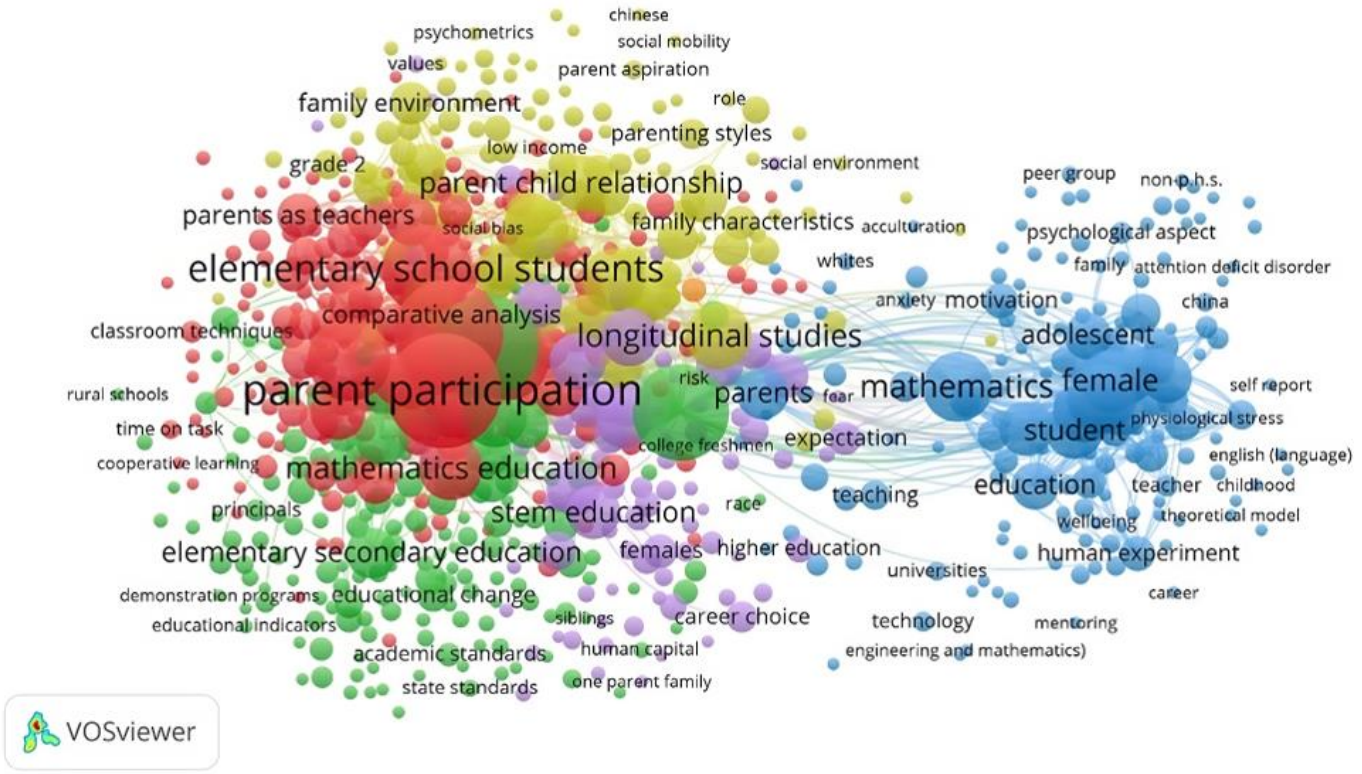

Figure 4. Network visualization of co-occurrence of the author's keywords (Source: Authors' own elaboration, using VOSviewer 1.6.20)

ability to succeed in mathematics. This finding validates the significance of parental involvement in children's early development of numerical skills within the household setting.

The keyword "human" in the blue cluster is linked to words such as "mathematics", "student", "child", "education", "parent", "motivation", and others. This cluster encompasses a broader range of studies on education and the participation of parents. The primary emphasis in this cluster is to examine many facets of parental involvement in education, namely in mathematics and student motivation. Moreover, within the yellow cluster, the term "longitudinal studies" is linked to the terms "mathematics skills", "parent child relationship", "student characteristics", "educational attainment", "family environment", "socioeconomic status", and other related terms. The yellow cluster is dedicated to conducting longitudinal studies that assess schooling progress over time. This cluster offers a comprehensive understanding of the longitudinal impact of familial and social factors on the development of children's mathematics education. This discovery aligns with the investigation conducted by Atasoy et al. (2022), which suggests that future studies examining the impact of ICT use, parental support, and challenges faced by children on student accomplishment should prioritize longitudinal study designs that incorporate students' backgrounds.

The keyword "gender differences" in the purple cluster is linked to terms such as "parent influence", "high school students", "STEM education", "self efficacy", "self concept", "secondary school students", and other related words. This cluster examines the disparities between genders in mathematical education, focusing on how gender influences the experiences and results of mathematics education. It also investigates the influence of parents in providing support to their children. This remark aligns with Chiu (2023) study, which examined the impact of biological, socioeconomic, and psychological elements within the family on the progression of children's mathematical proficiency. The findings indicated that all three elements advance children's mathematical proficiency.

The keyword "self determination" within the brown cluster lacks connections to other terms. This cluster centers around the notion of self-determination in the field of education. The concept of determination encompasses parents' self-confidence and motivation to actively engage and assist their children in learning mathematics. Additionally, the seventh cluster, shown by the color orange, has only one keyword, which is "age differences". This particular group of research studies examines the impact of age disparities on education, specifically in mathematics learning and parental involvement.

Furthermore, overlay visualization analysis of keyword occurrence was used to show the current research trend. The display of this overlay mapping is shown in **Figure 5**. According to **Figure 5**, the yellow network contains various keywords that indicate

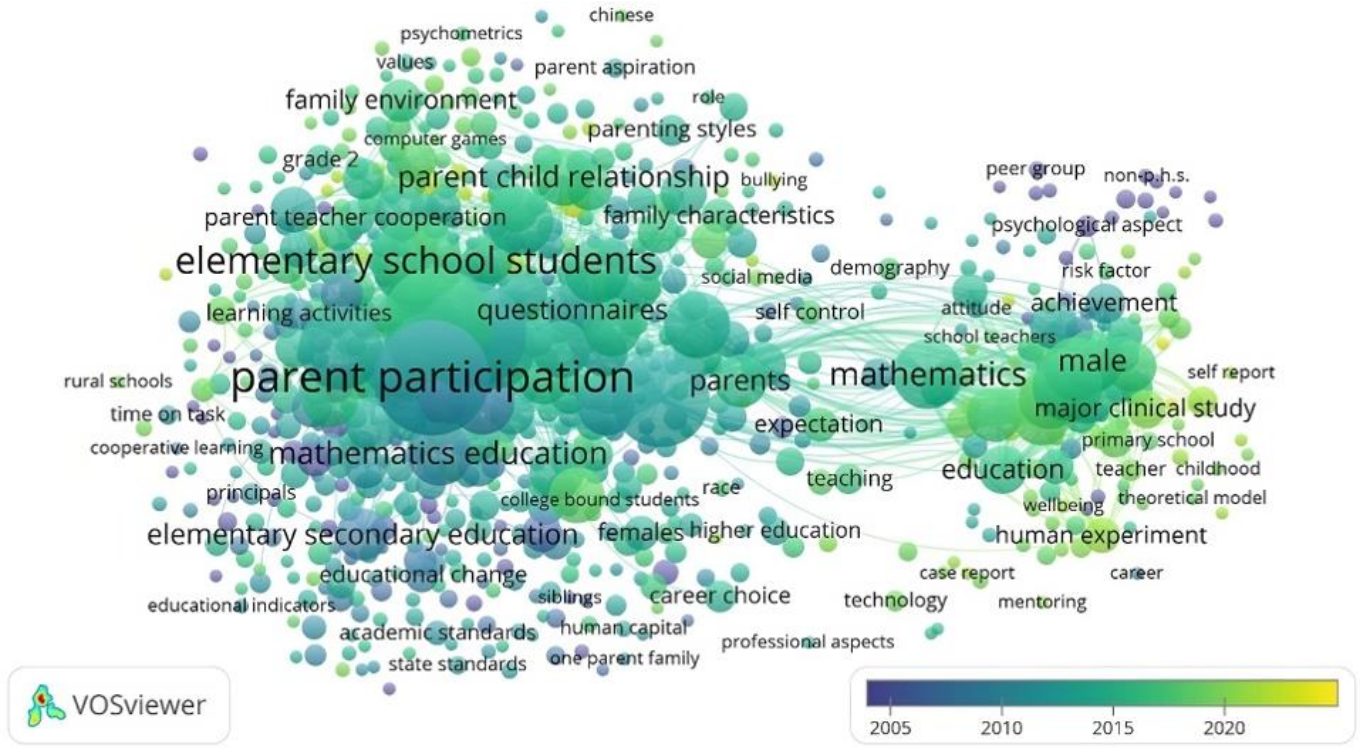

Figure 5. Overlay visualization of co-occurrence of the author's keywords (Source: Authors' own elaboration, using VOSviewer 1.6.20)

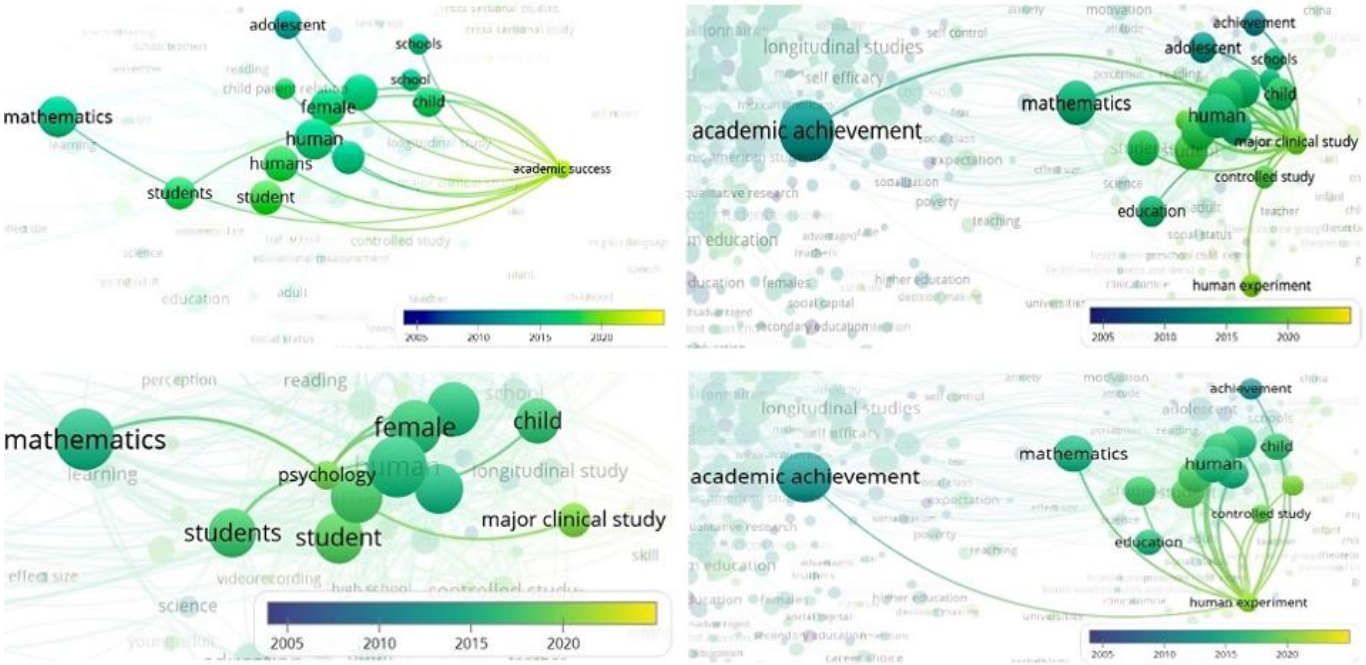

Figure 6. Overlay visualization of the co-occurrence of several keywords from the author (Source: Authors' own elaboration, using VOSviewer 1.6.20)

research trends from 2020 to the present (Marín-Marín et al., 2021; Moral-Muñoz et al., 2020). The cluster contains keywords such as "major clinical study", "human experiment", "academic success", "psychology", "public health", "wellbeing", "physiological stress", "e-learning", "covid-19", "pandemic", "bullying", "videorecording", "distance education", "technology uses in education", "electronic learning", and various other keywords.

Furthermore, a comprehensive examination of contemporary research terms such as "major clinical study", "human experiment", "academic success", and "psychology" was carried out to get insights into potential avenues for future research. **Figure 6** displays the analysis of these four keywords.

Figure 6 reveals that recent research has identified multiple keyword connections related to parental involvement in children's math's activities. The term "academic success" is present 16 times and has 107 connections with other keywords, resulting in a total association strength of 312. The keywords related to "academic success" encompassed terms such as "child", "school", "schools", "male", "female", "adolescent", "child parent relationship", "human", "humans", "article", "student", "students", and "mathematics". The term "psychology" is present 18 times and has 162 connections to other keywords, resulting in a cumulative link strength of 411. The relevant keywords encompassed "mathematics", "student", "students", "male", "female", "human", "humans", "article", "child", and "major clinical study". In addition, "major clinical study" appears 26 times and has 153 links with other terms. The overall strength of these interactions is 533. The keywords associated with "major clinical study" encompass terms such as "achievement", "school", "schools", "child", "adolescent", "male", "female", "human", "humans", "article", "psychology", "student", "students", "mathematics", and "academic achievement". The keyword "human experiment" was used 23 times and had 140 connections with other keywords, resulting in a total relationship strength of 470. Several keywords related to the term "human experiment" encompass "academic achievement", "mathematics", "education", "student", "students", "human", "humans", "female", "male", "article", "child", "controlled study", "achievement", and "major clinical study".

The overlay visualization study reveals the present research patterns about parental involvement in children's mathematics activities and the interconnected components that significantly impact their academic achievement. The term "academic success" is frequently mentioned in the literature and is associated with other keywords such as "child", "school", "male", "female", and "mathematics". The presence of these associations suggests that children's academic achievement is a primary area of investigation, with multiple factors playing a role, including the school setting, parent-child connections, and demographic variables such as gender and age.

The term "psychology" is also frequently included, suggesting the significance of psychological factors in promoting academic achievement. The significant correlation between "psychology" and keywords such as "mathematics", "student", and "child" underscores the growing importance of psychological approaches, particularly in comprehending children's motivations and views of mathematics. Contemporary studies primarily investigate the impact of psychological and emotional elements on parental involvement and children's performance in mathematics. Furthermore, the keywords "major clinical study" and "human experiment" suggest a notable inclination towards research that relies on experiments to understand the process of effective interventions better. Major clinical studies and human experiments provide empirical data that support the development of better educational strategies and interventions that can improve parental involvement and children's academic achievement. These keywords are strongly associated with the concepts of "achievement", "school", and "education", suggesting that this research prioritizes broader academic success and the lasting effects of different interventions.

Numerous studies on this topic recommend a multidisciplinary strategy combining clinical research, psychology, and education to understand better and enhance parental involvement in their children's mathematics education. Terms like "psychology" and "academic success" indicate the understanding that psychological and emotional elements play a role in academic performance, in addition to educational ones. Extensive clinical studies and human experiments show an increase in evidence-based approaches to finding the most effective strategies to support parental involvement and children's academic achievement.

Future research avenues could be pursued in light of these findings. The development of psychological interventions is the subject of the first opportunity. Through the involvement of parents in supporting the emotional and motivational components of their children's learning, psychological interventions aimed at increasing children's motivation and positive perception of mathematics can be developed and tested through further research. The second chance relates to longitudinal studies, which track participants from childhood to adulthood to examine the long-term effects of parental involvement in their children's mathematics education. This study can assist in determining the critical elements that influence a child's future performance in school and the workplace. To develop a more comprehensive understanding of and strategy for enhancing parental participation, the third research opportunity involves investigating a multidisciplinary approach through collaboration between education specialists, psychologists, and clinical studies. The multidisciplinary nature of this research is expected to reveal the intricate interplay among social, psychological, and educational elements. Additionally, a fourth area of study opportunity focuses on how parents might use technology to get more involved in their children's mathematics education. With the active involvement of parents, this study can evaluate the efficacy of online programs and platforms intended to enhance mathematics learning at home.

CONCLUSIONS

The study provides a comprehensive analysis and research summary of parental involvement in their children's ongoing mathematical endeavors, encompassing the current state of affairs, significant research trends, and suggestions for future research domains. Based on the utilized database, this issue has been examined from 1982 to 2024. In 2023, there was a peak in the number of publications, with a total of 80 papers being published. The study has additionally identified the preeminent authors, publications, and journals that substantially influence research trends concerning parental involvement in children's mathematical activities. Fan and Chen (2001) is the most significant author on this theme, with 1,574 citations. The visual mapping of the writers involved in this topic revealed that 2,375 authors contributed. The top-five authors who focused on this issue were Jianzhong Xu, James Reed Campbell, Marta Civil, Xin Ma, and Sandra D. Simpkins. These items were organized into seven clusters: the red cluster examines parental involvement in mathematics education across different countries; the green cluster investigates academic achievement in mathematics through the partnership between parents and schools; the blue cluster addresses various aspects of parental involvement in education, particularly in mathematics and student motivation; the yellow cluster focuses on longitudinal studies assessing educational progress over time; the purple cluster explores gender disparities in mathematics education, examining how gender influences educational experiences and outcomes and the role of parental support; the brown cluster centers on the concept of self-determination in education; and the orange cluster examines age differences in education, exploring how age impacts math learning and parental involvement.

Promising future research opportunities aligned with current research include developing psychological interventions to enhance children's motivation and positive perception of mathematics. Additionally, a longitudinal study could examine the enduring effects of parental involvement in their children's mathematics education by observing subjects from childhood to adulthood. A multidisciplinary approach involving collaboration among education experts, psychologists, and clinical researchers could be employed to gain a comprehensive understanding and enhance parental involvement in children's mathematics learning. Lastly, this topic could be juxtaposed by exploring the utilization of technology to augment parental involvement in their children's math education.

This study acknowledges the limitations of the use of a variety of keywords from the central database. The diversity of keywords employed in getting relevant article data may restrict the number of articles that may be located. Furthermore, while bibliometric analysis provides an initial means of comprehending and evaluating the potential of research on parental involvement in their child's mathematical activities, it is crucial to conduct further investigations that concentrate on the systematic literature review approach. These investigations are necessary to delve deeper into the conclusions derived from the bibliometric analysis. A comprehensive literature analysis can address these constraints, and a more comprehensive grasp of this study area can be attained.

Author contributions: AS & AK: formal analysis and investigation; **AS & MA:** writing–original draft preparation; **AS:** conceptualization; **S:** supervision; **PYF:** writing–review & editing; & **SH:** methodology. All authors have agreed with the results and conclusions.

Funding: No funding source is reported for this study.

Acknowledgments: The authors would like to thank Yogyakarta State University for their support in finalizing this article, which constitutes a segment of the child, family, and community studies course assignment. The authors would also like to thank the Centre for Higher Education Funding (Balai Pembiayaan Pendidikan Tinggi/BPPT) and the Education Fund Management Institution (Lembaga Pengelola Dana Pendidikan/LPDP) of the Republic of Indonesia for their assistance and financial backing in facilitating the author's academic pursuits.

Ethical statement: The authors stated that the study does not necessitate the involvement of an ethical committee as the study does not include any experiments or research involving humans or animals. Furthermore, the study utilized data that is accessible in the public domain.

Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

REFERENCES

Anderson, S. L. (1982). Turning around junior highs in the district of Columbia. *Educational Leadership, 40*(3), 38-40.

Ashton, J., Griffiths, G., Kaye, D., Kelly, B., & Marsh, D. (2011). Family mathematics/numeracy: Identifying the impact of supporting parents in developing their children's mathematical skills. *Proceedings of the British Society for Research into Learning Mathematics, 31*(1), 7-12.

Atasoy, R., Çoban, Ö., & Yatagan, M. (2022). Effect of ICT use, parental support and student hindering on science achievement: Evidence from PISA 2018. *Journal of Learning and Teaching in Digital Age, 7*(2), 127-140. https://doi.org/10.53850/joltida.945869

Averill, R., Metson, A., & Bailey, S. (2016). Enhancing parental involvement in student learning. *Curriculum Matters, 12*, 109-131. https://doi.org/10.18296/cm.0016

Bellon, E., van Bergen, E., & Dowker, A. D. (2022). Is parental mathematics anxiety associated with young children's arithmetical performance? *Education Sciences, 12*(11), Article 812. https://doi.org/10.3390/educsci12110812

Benbow, C. P. (1988). Sex differences in mathematical reasoning ability in intellectually talented preadolescents: Their nature, effects, and possible causes. *Behavioral and Brain Sciences, 11*(2), 169-183. https://doi.org/10.1017/S0140525X00049244

Block, J. H., & Fisch, C. (2020). Eight tips and questions for your bibliographic study in business and management research. *Management Review Quarterly, 70*(3), 307-312. https://doi.org/10.1007/s11301-020-00188-4

Chiu, M.-S. (2023). Gender differences in mathematical achievement development: A family psychobiosocial model. *European Journal of Psychology of Education, 38*(4), 1481-1504. https://doi.org/10.1007/s10212-022-00674-1

Choi, J., & Han, H. S. (2020). Do parental attitudes really matter to children's mathematics anxiety? A meta-analysis. *Universal Journal of Educational Research, 8*(5), 1731-1740. https://doi.org/10.13189/ujer.2020.080509

Coulombe, G. (1995). Parental involvement: A key to successful schools. *NASSP Bulletin, 79*(567), 71-75. https://doi.org/10.1177/019263659507956711

Cui, Y., Zhang, D., & Leung, F. K. S. (2021). The influence of parental educational involvement in early childhood on 4th grade students' mathematics achievement. *Early Education and Development, 32*(1), 113-133. https://doi.org/10.1080/10409289.2019.1677131

DiStefano, M., Retanal, F., Bureau, J. F., Hunt, T. E., Lafay, A., Osana, H. P., Skwarchuk, S. L., Trepiak, P., Xu, C., LeFevre, J. A., & Maloney, E. A. (2023). Relations between math achievement, math anxiety, and the quality of parent-child interactions while solving math problems. *Education Sciences, 13*(3), Article 307. https://doi.org/10.3390/educsci13030307

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research, 133*, 285-296. https://doi.org/10.1016/j.jbusres.2021.04.070

Đurišić, M., & Bunijevac, M. (2017). Parental involvement as a important factor for successful education. *Center for Educational Policy Studies Journal, 7*(3), 137-153. https://doi.org/10.26529/cepsj.291

Fan, X., & Chen, M. (2001). Parental involvement and students' academic achievement: A meta-analysis. *Educational Psychology Review, 13*, 1-22. https://doi.org/10.1023/A:1009048817385

Fuligni, A. J. (1997). The academic achievement of adolescents from immigrant families: The roles of family background, attitudes, and behavior. *Child Development, 68*(2), 351-363. https://doi.org/10.1111/j.1467-8624.1997.tb01944.x

Goshin, M., & Mertsalova, T. (2018). Types of parental involvement in education, socio-economic status of the family and students' academic results. *Educational Studies, 3*, 68-90. https://doi.org/10.17323/1814-9545-2018-3-68-90

Hernández-Padilla, E., Bazán-Ramírez, A., Bazán-Ramírez, W., & Solano-Gutierrez, J. (2023). Parental participation and parents' support: Effects on mathematics achievement, 2018 national assessment of learning, Mexico. *Frontiers in Psychology, 14*, Article 1154470. https://doi.org/10.3389/fpsyg.2023.1154470

Hong, S., Yoo, S. K., You, S., & Wu, C. C. (2010). The reciprocal relationship between parental involvement and mathematics achievement: Autoregressive cross-lagged modeling. *Journal of Experimental Education, 78*(4), 419-439. https://doi.org/10.1080/00220970903292926

Huang, F., Huang, Z., Li, Z., & Zhang, M. (2021). Relationship between parental involvement and mathematics achievement of Chinese early adolescents: Multiple mediating roles of mental health and mathematics self-efficacy. *International Journal of Environmental Research and Public Health, 18*, Article 9565. https://doi.org/10.3390/ijerph18189565

Ing, M. (2014). Can parents influence children's mathematics achievement and persistence in STEM careers? *Journal of Career Development, 41*(2), 87-103. https://doi.org/10.1177/0894845313481672

Jay, T., Rose, J., & Simmons, B. (2018). Why is parental involvement in children's mathematics learning hard? Parental perspectives on their role supporting children's learning. *SAGE Open, 8*(2). https://doi.org/10.1177/2158244018775466

Kantova, K. (2024). Parental involvement and education outcomes of their children. *Applied Economics, 56*(48), 5683-5698. https://doi.org/10.1080/00036846.2024.2314569

Kassis, W., Dueggeli, A., Govaris, C., Kassis, M., Dittmar, M., Aksoy, D., & Favre, C. A. (2024). Longitudinal negotiation, navigation processes, and school success in high school: A two-wave latent transition approach. *Adversity and Resilience Science, 5*, 219-240. https://doi.org/10.1007/s42844-024-00126-3

Kaya, D., & Ok, G. (2022). Problems encountered by mathematics and science teachers in classrooms where Syrian students under temporary protection status are educated and suggestions for solution. *International Journal of Contemporary Educational Research, 8*(1), 111-127. https://doi.org/10.33200/ijcer.774094

Kelly, J., Sadeghieh, T., & Adeli, K. (2014). Peer review in scientific publications: Benefits, critiques, & a survival guide. *The Journal of the International Federation of Clinical Chemistry and Laboratory Medicine, 25*(3), 227-243.

Kyeremeh, P., & Dorwu, E. (2022). Supporting young children's mathematical development: The role of parents. *International Online Journal of Primary Education, 11*(2), 320-337. https://doi.org/10.55020/iojpe.1218741

Leana, C. R., & Pil, F. K. (2006). Social capital and organizational performance: Evidence from urban public schools. *Organization Science, 17*(3), 353-366. https://doi.org/10.1287/orsc.1060.0191

Marín-Marín, J. A., Moreno-Guerrero, A. J., Dúo-Terrón, P., & López-Belmonte, J. (2021). STEAM in education: A bibliometric analysis of performance and co-words in Web of Science. *International Journal of STEM Education, 8*, Article 41. https://doi.org/10.1186/s40594-021-00296-x

McDonnall, M. C., Cavenaugh, B. S., & Giesen, J. M. (2012). The relationship between parental involvement and mathematics achievement for students with visual impairments. *Journal of Special Education, 45*(4), 204-215. https://doi.org/10.1177/0022466910365169

Møller, A. K., & Kaup, C. F. (2023). Parents' and children's learning when collaborating on inquiry-based mathematics and computational thinking tasks. *Journal of Pedagogical Research, 7*(2), 108-126. https://doi.org/10.33902/JPR.202319033

Moral-Muñoz, J. A., Herrera-Viedma, E., Santisteban-Espejo, A., & Cobo, M. J. (2020). Software tools for conducting bibliometric analysis in science: An up-to-date review. *Profesional De La información, 29*(1). https://doi.org/10.3145/epi.2020.ene.03

Rodríguez, S., Piñeiro, I., Gómez-Taibo, M. L., Regueiro, B., Estévez, I., & Valle, A. (2017). An explanatory model of maths achievement: Perceived parental involvement and academic motivation. *Psicothema, 29*(2), 184-190. https://doi.org/10.7334/psicothema2017.32

Sachdeva, A. C. (2023). Role of parental involvement in student education with special reference to private college in Delhi. *Tuijin Jishu/Journal of Propulsion Technology, 44*(4), 6275-6283. https://doi.org/10.52783/tjjpt.v44.i4.2134

Scheer, J. K., & Henniger, M. T. (1982). Math clinic: An ideal setting for parental involvement. *Arithmetic Teacher, 30*(2), 48-51. https://doi.org/10.5951/AT.30.2.0048

Secinaro, S., Brescia, V., Calandra, D., & Biancone, P. (2020). Employing bibliometric analysis to identify suitable business models for electric cars. *Journal of Cleaner Production, 264*, Article 121503. https://doi.org/10.1016/j.jclepro.2020.121503

Serin, H. (2023). Mathematics anxiety: Overcoming challenges and achieving success. *International Journal of Social Sciences & Educational Studies, 10*(2), 383-389. https://doi.org/10.23918/ijsses.v10i2p383

Sheldon, S. B., & Epstein, J. L. (2005). Involvement counts: Family and community partnerships and mathematics achievement. *Journal of Educational Research, 98*(4), 196-207. https://doi.org/10.3200/JOER.98.4.196-207

Shukla, S. Y., Tombari, A. K., Toland, M. D., & Danner, F. W. (2015). Parental support for learning and high school students' academic motivation and persistence in mathematics. *Journal of Educational and Developmental Psychology, 5*(1), 44-56. https://doi.org/10.5539/jedp.v5n1p44

Silinskas, G., & Kikas, E. (2019). Parental involvement in math homework: Links to children's performance and motivation. *Scandinavian Journal of Educational Research, 63*(1), 17-37. https://doi.org/10.1080/00313831.2017.1324901

Soni, A., & Kumari, S. (2017). The role of parental math anxiety and math attitude in their children's math achievement. *International Journal of Science and Mathematics Education, 15*(2), 331-347. https://doi.org/10.1007/s10763-015-9687-5

Sui-Chu, E. H., & Willms, J. D. (1996). Effects of parental involvement on eighth-grade achievement. *Sociology of Education, 69*(2), 126-141. https://doi.org/10.2307/2112802

Vukovic, R. K., Roberts, S. O., & Green Wright, L. (2013). From parental involvement to children's mathematical performance: The role of mathematics anxiety. *Early Education and Development, 24*(4), 446-467. https://doi.org/10.1080/10409289.2012.693430

Wu, Y., Hilpert, P., Tenenbaum, H., & Ng-Knight, T. (2022). A weekly-diary study of students schoolwork motivation and parental support. *British Journal of Educational Psychology, 92*, 1667-1686. https://doi.org/10.1111/bjep.12532

Yang, Q. T., Star, J. R., Harris, P. L., & Rowe, M. L. (2023). Chinese parents' support of preschoolers' mathematical development. *Journal of Experimental Child Psychology, 236*, 105753. https://doi.org/10.1016/j.jecp.2023.105753

Yaro, K. (2015). *Parental involvement in children's mathematics learning: A case of a rural community, Ghana* [Master's thesis, University of British Columbia].

Zhou, J., Liu, H., Wen, H., Wang, X., Wang, Y., & Yang, T. (2022). The association between physical activity and mathematical achievement among Chinese

fourth graders: A moderated moderated-mediation model. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.862666

Zhu, H., Li, J., Yuan, Z., & Li, J. (2023). Bibliometric analysis of spatial accessibility from 1999-2022. *Sustainability, 15*(18), Article 13399. https://doi.org/10.3390/su151813399

Zhu, J., & Chiu, M. M. (2019). Early home numeracy activities and later mathematics achievement: Early numeracy, interest, and self-efficacy as mediators. *Educational Studies in Mathematics, 102*(2), 173-191. https://doi.org/10.1007/s10649-019-09906-6

Zupic, I., & Čater, T. (2015). Bibliometric methods in management and organization. *Organizational Research Methods, 18*(3), 429-472. https://doi.org/10.1177/1094428114562629