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Quantifying research productivity on science anxiety experienced by students and teachers: a bibliometric study

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Abstract. *Science subjects are often regarded as difficult by some students and teachers due to their theoretical nature, the need for hands-on experimentation, and the use of scientific methods. The notion that "science is hard" evokes negative emotions, such as anxiety, towards science teaching and learning. This study aims to quantify research productivity related to anxiety experienced by teachers and students when learning science subjects. A bibliometric study was employed, involving 680 documents published from 2016 to 2026. Data were compiled from the Scopus database using Boolean codes related to science anxiety. Data cleaning was performed by applying inclusion and exclusion criteria on the Scopus website, manual cleaning in Microsoft Excel, and using OpenRefine software. Data analysis was carried out using RStudio and VOSViewer. It is perceived that the publications on science anxiety are escalating, especially those produced by Beijing Normal University. Moreover, in terms of country, the USA possesses the most productive and cited country on the subject. To sum up, studies on anxiety experienced by students and teachers are found mostly in mathematics subjects. Thus, research on students' and teachers' anxiety in science subjects is a research hotspot.*

Keywords: Anxiety; Science Education; Students; Teachers

INTRODUCTION

Science education is essential, as it not only deepens students' understanding but also enhances their scientific skills. In terms of teaching, science teaching differs from teaching other subjects. It requires not only that teachers discuss theories but also that they connect them to real-life phenomena, which are generalized into scientific theories through observation and experimentation (Holbrook & Rannikmae, 2007). However, due to the difficulty in understanding comprehension and experimenting with scientific concepts, science is often recognized as a challenging subject (Mallow, 2006; Udo et al., 2004) that induces significant psychological shifts in both teachers and students. One of the psychological issues that teachers and students often experience in teaching and learning science is anxiety. It is a negative emotion that influences cognitive processes (Zaccoletti et al., 2020), the perceived threat of failure, and the belief in incompetence, which affect self-worth (Covington, 1992). In science teaching and learning, anxiety influences the performance of both teachers and students (Galimova et al., 2024).

The anxiety experienced by teachers is mostly related to a lack of understanding of scientific knowledge, limited pedagogical content knowledge, low self-efficacy in teaching science, and poor communication skills (Burrell et al., 2025; Matoti & Lekhu, 2016; Yürük, 2011). From a practical perspective, anxiety may pose challenges for teachers in managing the classroom environment and preparing lessons, potentially affecting their confidence and leading to fear of making mistakes (Matoti & Lekhu, 2016). It is a negative feeling that affects teachers' ability to start, conduct, and end lessons (Yürük, 2011). In constructing a lesson plan, for instance, anxiety can challenge teachers to choose appropriate teaching techniques and

strategies (Boger & Boger, 2000). They may also not be able to anticipate students' conditions in real teaching (Matoti & Lekhu, 2016). Interestingly, previous studies have shown that teachers' anxiety is also influenced by their past experiences learning science as students (Novak et al., 2022; Yürük, 2011). Teachers' anxiety influences students' anxiety, as this feeling is transmitted during the learning process (Christensen & Osgood, 2023; McLean et al., 2017). Negative emotions such as anxiety can hinder students' performance in science learning, discouraging them from learning science and reducing their interest in science learning (Degorio et al., 2023). This emotional condition leads teachers to avoid interactive and inquiry-based learning methods to reduce unpredictability and maintain teacher control (DeCoito & Richardson, n.d.; Dreon & McDonald, 2012) and to conduct teacher-centered classes (Czerniak & Schriver, 1994; Yürük, 2011). Therefore, teachers' anxiety may negatively impact science instruction, ultimately affecting students' understanding and scientific skills (Dreon & McDonald, 2012; Novak et al., 2022).

Students' science anxiety also often occurs. It is shaped by several factors, including teachers' instructional methods, individual students' characteristics, high-stakes assessment (Gervacio, 2024), and scientific terminology that also poses additional challenges (Ghimire, 2023). Anxiety experienced by students may develop during science learning or from negative experiences, such as failing a science examination, encountering an intimidating teacher, or failing experiments (Christensen & Osgood, 2023). Such anxiety may negatively affect students' attitude toward science, learning behavior, scientific decision-making capability, willingness to enroll in science-related courses (Cumming & Harris, 2001; Daker et al., 2021), cognitive and affective performance, and even affect students' health (Bostani et al., 2014; Vitasari et al., 2010). In contrast, students with a low level of anxiety are found to be more engaged, cooperative, and active in learning activities (McInerney et al., 1997). However, students are less anxious when working in a group, as they feel more focused, accepted, and able to collaborate in various ways to solve problems (Cooper et al., 2018).

The relationship between students and teachers during science learning is essential, as positive student-teacher relationships are associated with greater self-efficacy and lower anxiety (Kurbanoğlu et al., 2023). Anxiety experienced by both teachers and students in science teaching and learning has consequences for students' achievement, the learning environment, students' avoidance of science-related subjects, students' future career choices, and the overall quality of science instruction. In conclusion, anxiety experienced by teachers and students in science teaching and learning may produce long-term consequences for the quality of science education when it is not properly addressed. Teacher anxiety can affect instructional confidence, classroom practices, and the delivery of science content, while student anxiety can influence learning engagement, attitudes toward science, scientific decision-making, and participation in science-related subjects. These effects indicate that science anxiety is not only an individual psychological issue but also an educational concern that may shape the overall effectiveness of science instruction. Therefore, this topic requires systematic investigation. This study aims to identify research trends and gaps in studies on anxiety in science teaching and learning by analyzing publications indexed in the Scopus database. Previous bibliometric studies have examined mathematics anxiety and science anxiety in general. However, limited attention has been given to bibliometric evidence on anxiety experienced by both teachers and students within science classroom contexts. By addressing this gap, the present study provides a structured overview of the literature and offers direction for future research on anxiety in science education.

METHOD

This study employs a bibliometric approach to quantitatively analyze research on science anxiety among teachers and students. This is a research method that analyzes quantitative patterns of published articles (Manoj Kumar L. et al., 2023). Data were analyzed using several software packages, including Microsoft Excel, OpenRefine, RStudio with the bibliometrix package, and VOSViewer. This study uses 680 Scopus-indexed articles collected on 20th May 2026, following these Boolean queries (see Table 1).

Table 1. Boolean Queries of Teachers' and Students' Science Anxiety

Stage	Boolean Query
#1	"teacher*" OR "educator*" OR "instructor*" OR "student*" OR "pupil*" OR "learner*"
#2	"anxiety" OR "stress" OR "emotional strain"
#3	"science education" OR "biology" OR "physics" OR "chemistry" OR "mathematics" OR "STEM"

To obtain appropriate data for analysis, inclusion and exclusion criteria were applied, as shown in Table 2.

Table 2. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Subject Area	Related to social science, psychology, arts and humanities, and science education	Subject area unrelated to the topic
Document	Article	Non-article
Language	English	Non-English
Keyword	All keywords related to science anxiety experienced by teachers and students	Unrelated keywords to the topic
Source type	Journal	Book
Publication stage	Final	On press
Publication year	2016-2026	Outside timeframe

Specifically, the research flow is presented in Figure 1.

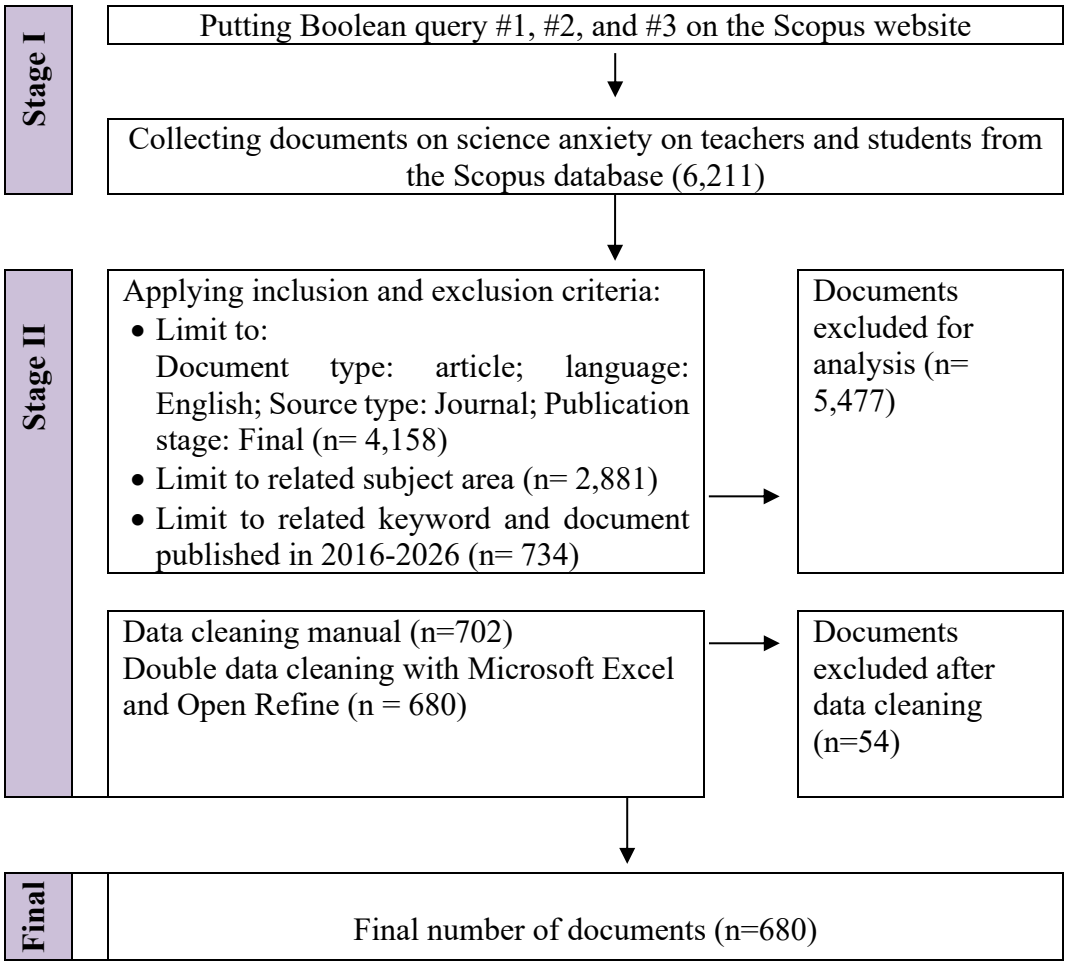

Figure 1. Document Collection Phase

RESULT AND DISCUSSION

General Information on Bibliometric Data

In the first stage, the authors collected data from the Scopus database on anxiety experienced by teachers and students in the teaching and learning of science subjects. Some limitations were applied based on the inclusion and exclusion criteria presented in Table 2. This study covers publications on the topic from 2016 to 2026, resulting in 680 Scopus-indexed articles. Table 3 presents the main information on the documents used in this study: 680 articles were published across 319 journals, with an average citation per article of 15.87. Moreover, among published articles, only 70 are single-authored, while 610 are collaborative, involving 2,012 (2,082-70) authors, yielding an average of 3.68 co-authors per document and 23.53% international co-authorship. It is also evident that the total number of references across 680 published articles is 34,934, indicating an average of 51.37 references per document. This suggests that future research on science anxiety should include at least 52 references. This result aligns with several bibliometric studies indicating that some Scopus-indexed journals should include at least 43 references (Jamali et al., 2023; Utami & Winarno, 2026).

Table 3. Data Main Information

No.	Description	Results
1.	Timespan	2016-2026
2.	Journal Sources	319
3.	Documents Number	680
4.	Average Citation per Document	15.87
5.	Reference Number	34,934
6.	Author's Keywords	1,569
7.	Author Number	2,082
8.	Single-authored Document	70
9.	Average Co-authors per Document	3.68
10.	International Co-authorship	23.53%

Productive Affiliations and Countries

The study that analyzes the most productive affiliations and countries is conducted using the Bibliometrix package in RStudio. Five affiliations were captured that produced the highest number of publications related to anxiety experienced by teachers and students in science teaching and learning. Figure 2 shows that Beijing Normal University produced the most documents, followed by the University of California and the University of Johannesburg in second and third place, respectively. Interestingly, the University of California had the most productive affiliation on the topic from 2016 to 2019, while Beijing Normal University did not publish on the topic during that period. However, in the following years, although the number of publications produced by the University of California is increasing, the increase is not as significant as the number of documents produced by Beijing Normal University researchers, which rose sharply, peaking at around 25 in 2026. In contrast, the documents published by researchers from the University of Johannesburg, Loughborough University, and the University of Tartu were limited to no more than 10 publications each year.

Table 4 depicts the most productive countries on the topic, showing that the USA produced 350 Scopus-indexed documents related to science anxiety, leading in first position, followed by China and the UK in second and third positions, with 134 and 110 articles, respectively. Moreover, Turkey and Germany rank 4th and 5th, with publication counts below 100 over the 10-year period. It is no wonder that the US is in the first position, as other bibliometric study also consistent with the findings of this study, which shows that the United States is the most productive country in the field of psychology (Allik, 2013), science education (Le Thi Thu et al., 2021), and artificial intelligence in education (Sun & Saleh, 2024).

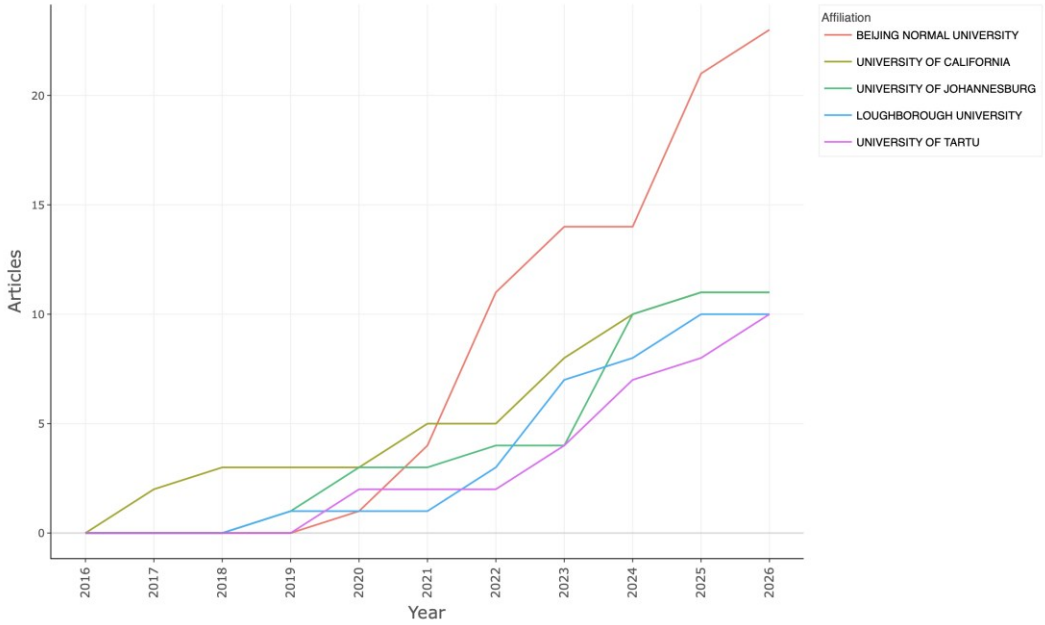

Figure 2. Productive Affiliations

Table 4. Analysis on Authors Countries

No.	Country	Publication	Citation	Average Document Citations
1.	USA	350	2,739	20.10
2.	China	134	740	12.10
3.	UK	110	458	17.00
4.	Turkey	98	491	11.20
5.	Germany	66	847	30.20

Citation Analysis on Author, Journal, and Article

Three criteria were considered for citation analysis of author and journal sources: h-index, citations, and the number of published documents, which were analyzed using the bibliometrix package in RStudio. Table 5 shows the results of the author citation analysis, ranked by citation count. As can be seen, Reinhard Pekrun from the University of Essex was among the most-cited authors, with an h-index of 5 and 757 total citations, having published 5 documents in 2016-2026 related to anxiety. This means the average number of citations per document is 151.4 (757/5). In the second position, Sial L. Beilock is captured as the second most cited author. She is a researcher at Dartmouth who has produced five documents on the topic, averaging 146 citations per document (730/5). Moreover, Susan Levine from the University of Chicago is the third most-cited author with a total of 631 citations from four published articles. In fourth position is Erin A. Maloney from the University of Ottawa, followed by Gerardo Ramirez from Ball State University in fifth, with total citation counts of 398 and 394, respectively.

Table 5. Author Citation Analysis

No.	Author	h_index	Citation	Documents
1.	Pekrun R	5	757	5
2.	Beilock SL	5	730	5
3.	Levine SC	4	631	4
4.	Maloney EA	5	398	5
5.	Ramirez G	3	394	3

To examine the most widely distributed journal, citation analysis was conducted on journal sources using the Bibliometrix package in RStudio. As shown in Table 6, the British Journal of Educational Psychology has the highest number of citations (659), with 22 documents published on the related topic. This journal is published by Wiley-Blackwell in the United States, indexed in the first Quartile with an impact factor of 3.6. In the second position, Frontiers in Psychology had a higher h-index score (16) and a higher number of published articles (27), but a slightly lower total citation count (613). This journal is published in Switzerland by Frontiers Media SA,

with a 2.9 impact factor considered in the first quartile in Scopus. Moreover, in the third position, Learning and Individual Differences had 365 total citations from 13 published documents on the topic, followed by Annals of the New York Academy of Sciences and Contemporary Educational Psychology in fourth and fifth place, respectively. Overall, the five most-cited journal sources are indexed in the first quartile by Scopus.

Table 6. Journal Citation Analysis

No.	Journal	h_index	Citation	Documents
1.	British Journal of Educational Psychology	12	659	22
2.	Frontiers in Psychology	16	613	27
3.	Learning and Individual Differences	10	365	13
4.	Annals of the New York Academy of Sciences	7	147	10
5.	Contemporary Educational Psychology	6	190	10

Table 7 shows the five most cited documents related to anxiety experienced by teachers and students. First, Camacho-Morles et al. (2021) conducted a meta-analysis of the relationship between students' achievement emotion and academic performance across 69 articles. The results show that negative emotions are associated with lower academic performance, whereas learning enjoyment is associated with better learning outcomes. This study, published in Educational Psychology Review, has been cited 377 times. The second-, third-, and fourth-most-cited articles are related to mathematics anxiety, which receives around 250-295 citations and were published in the first quartile of Scopus-indexed journals. Lastly, a document by Ng et al. (2024) reported a three-week experiment with two groups of students using generative AI (SRLbot) and rule-based AI (Nemobot) chatbots and found that the gen AI-based class had lower science learning anxiety and better learning motivation, academic performance, and learning behavior.

Table 7. Most Cited Documents

No.	Author	Title	Journal	Citation
1.	Camacho-Morles, et al. (2021)	Activity Achievement Emotions and Academic Performance: A Meta-analysis	Educational Psychology Review	377
2.	Foley, Alana E., et al.	The Math Anxiety-Performance Link: A Global Phenomenon (2017)	Current Directions in Psychological Science	295
3.	Ramirez, Gerardo, et al.	On the Relationship between Math Anxiety and Math Achievement in Early Elementary School: The Role of Problem Solving Strategies (2016)	Journal of Experimental Child Psychology	283
4.	Namkung, J. M., Peng, P., & Lin, X. (2019)	The Relation Between Mathematics Anxiety and Mathematics Performance Among School-Aged Students: A Meta-Analysis	Review of Educational Research	259
5.	Ng DT, Tan CW, & Leung JK. (2024)	Empowering Student Self-Regulated Learning and Science Education Through Chatgpt: A Pioneering Pilot Study	British Journal of Educational Technology	232

Co-Citation Analysis on Authors and Journal Sources

The aim of co-citation analysis is to map similarities and assess the alignment of articles based on citation networks (Boyack & Klavans, 2010). In this co-citation analysis, the minimum citation count is set to 10, so articles with fewer than 10 citations are excluded from the study. Of 20,650 authors, 425 meet the threshold and are used for analysis. As shown in Figure 3, the authors' co-citation analysis identifies four clusters (red, blue, green, and yellow). Authors in the

same clusters are more likely to be cited together (Utami et al., 2025). The different colors of the clusters correspond to different research variables (Kocak et al., 2019). Moreover, in Figure 3, it is noticeable that Beilock S.L, Hembree R., and Szucs D have bigger node sizes compared to other authors, which represents the higher citation number.

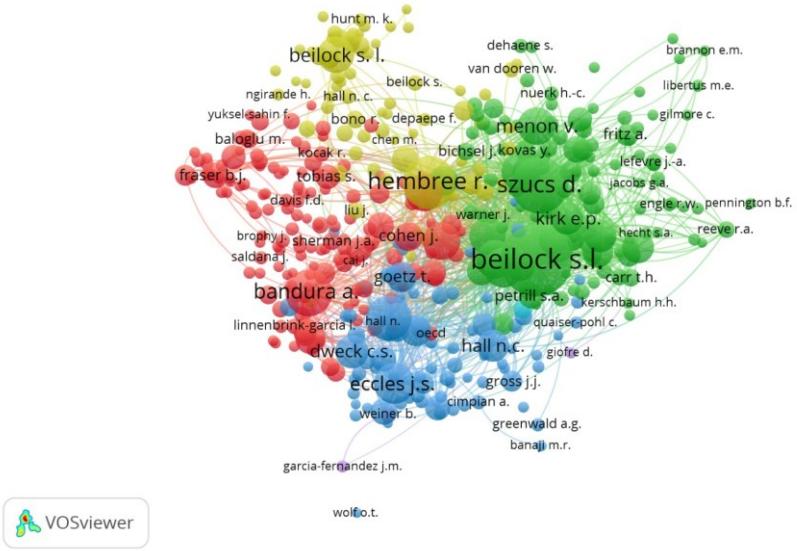

Figure 3. Co-citation Analysis on Authors

Figure 4 shows the result of co-citation mapping on the journal sources. The co-citation analysis was conducted to capture how these journals are cited together. The citation threshold was set to 10, from 12,675 journal sources; 548 met the threshold, meaning that only journals with more than 10 citations are used in this study. There are four different clusters identified by different colors (red, yellow, green, and blue). It is noticeable that Frontiers in Psychology is the most distinct node. This journal is in the first quartile and has received high citation counts. Figure 4 also shows that some nodes are clustered together, while others are dispersed. The different spatial positions of the nodes indicate distinct thematic relationships among journals (Talan, 2021).

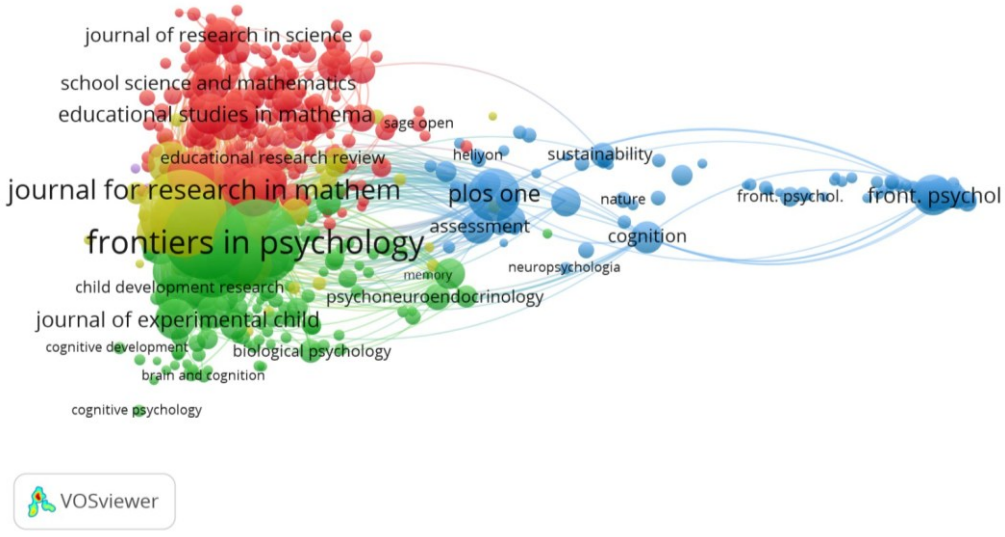

Figure 4. Co-citation Analysis on the Journal Sources

Co-occurrence Analysis on the Author Keywords

Co-occurrence analysis aims to map and analyze the underlying conceptual networks embedded within a body of literature (Tijssen & Van Raan, 1994). In this study, co-occurrence analysis was conducted on the authors' keywords on the VOSviewer software. The result is depicted in Figure 5, where anxiety, male, math anxiety, and chemistry are captured in the large nodes. In co-occurrence analysis, node sizes indicate the frequency of keyword usage (Lozano et al., 2019). The network mapping from author keyword co-occurrence analysis reveals a significant gap for further research. For instance, the word "male" appeared in the large node, indicating an increasing research interest in how demographic variables influence science anxiety. Science anxiety manifests differently across genders, influencing their future enrollment in science-related courses (Brownlow et al., 2000). Beyond demographic variables, the co-occurrence analysis demonstrates strong thematic structure across academic disciplines, with mathematics and science subjects (such as chemistry) forming large nodes. The result underscores that mathematics and science-related subjects contribute to anxiety experienced by teachers and students in teaching and learning practices. Future research may address these gaps by determining whether anxiety is defined by gender differences in mathematics and science subjects.

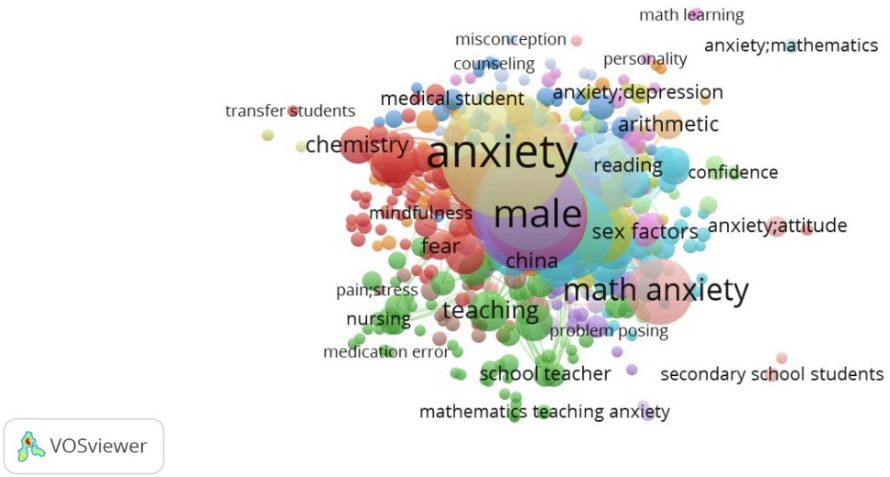

Figure 5. Co-occurrence Analysis on the Author Keywords

CONCLUSION

This bibliometric study presents quantitative data on current research trends in science anxiety among teachers and students. The documents were compiled from the Scopus database published from 2016 to 2026, following several inclusion and exclusion criteria, resulting in 680 articles used in this study. The results show an upward trajectory in annual publication volume, with Beijing Normal University and the United States emerging as the most productive affiliation and country, respectively. Furthermore, citation analysis identified key foundational researchers, including Reinhard Pekrun of the University of Essex, as the most-cited. Meanwhile, the top-most-cited journals are all positioned within the first quartile (Q1) of the Scopus database. Thematic mapping and keyword co-occurrence analysis revealed intersections among anxiety, gender differences, mathematics, and science subjects, such as chemistry, which had denser, larger nodes, indicating that research on gender differences transitioned from an emerging topic to a dominant research hotspot. Despite its insights, this study is subject to certain limitations. The dataset was only obtained from the Scopus database. Future bibliometric studies should integrate multi-database sources, such as Web of Science (WOS) and Google Scholar, to provide a more holistic analysis.

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