

## A bibliometric analysis covering the relevant literature on science anxiety over two decades

Aygul A. Khafizova<sup>1\*</sup> , Sergei P. Zhdanov<sup>2</sup> , Oksana V. Beltyukova<sup>3</sup> , Natalia I. Lapidus<sup>4</sup> ,  
Ludmila Y. Grebenshchikova<sup>5</sup> , Irina V. Lushchik<sup>6</sup> 

<sup>1</sup> Department of Higher School Pedagogy, Kazan Federal University, Kazan, RUSSIA

<sup>2</sup> Department of Civil Law Disciplines, Plekhanov Russian University of Economics, Moscow, RUSSIA

<sup>3</sup> Department of Psychology, Vyatka State University, Kirov, RUSSIA

<sup>4</sup> Department of Medical and Social Assessment, Emergency, and Ambulatory Practice, Sechenov First Moscow State Medical University, Moscow, RUSSIA

<sup>5</sup> Department of Reproductive Medicine and Perinatology, Tver State Medical University, Tver, RUSSIA

<sup>6</sup> Department of Finance and Monetary and Credit Relations, Russian Foreign Trade Academy, Moscow, RUSSIA

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### Abstract

This study aimed to examine publications related to science anxiety to contribute to developing relevant literature. A bibliometric analysis was conducted on 71 articles published between 2003 and 2022 from the Scopus database. The analysis examined the bibliographic links between the sources, authors, countries, and publications through the VOSviewer software. The results regarding keyword analysis showed that the five most frequently used keywords in the selected articles are anxiety, science anxiety, students, self-efficacy, and education. The results also showed that 80% of research papers on science anxiety, among the top 10 highest cited publications, were conducted in the USA. All of the top-10 publications were published in journals that have published articles in education literature for a long time. In addition, the results indicated that half of the publications also used psychology education journals. Furthermore, the bibliographic coupling of the authors showed that research teams from the USA authored the most publications on science anxiety. In light of the results, recommendations for future studies are made in conclusion.

**Keywords:** bibliometric analysis, science anxiety, science education

## INTRODUCTION

In the ever-evolving landscape of education, science, technology, engineering, and mathematics (STEM) play a vital role in society's progress, innovation, and development (Ardianto et al., 2023; Hasanah, 2020). The demand for a workforce with strong STEM skills is rising today (Irwanto et al., 2022; Murphy, 2018). However, one of the significant obstacles to promoting students' interests and encouraging them to have a career in STEM fields is science anxiety (Gregg et al., 2016; Henschel, 2021). This psychological phenomenon can profoundly impact STEM education's learning experience and outcomes (Henschel, 2021; Hong, 2009). Therefore, this issue is critical to unlocking the full potential of STEM

education. Like mathematics anxiety, science anxiety refers to the fears and anxieties arising when learning and engaging with scientific concepts and activities (Henschel, 2021; Megreya et al., 2021; Utha et al., 2021). This phenomenon is not restricted to a particular age group or academic level, and it affects students across all levels of education—from elementary school to higher education (Griggs et al., 2013; Henschel, 2021; Megreya et al., 2021). As the academic community increasingly recognizes the significance of promoting STEM skills in the face of future global challenges, it becomes essential to address science anxiety to create an inclusive and effective educational environment (Biktagirova et al., 2022).

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✉ [aigulj@mail.ru](mailto:aigulj@mail.ru) (\*Correspondence) ✉ [zhdanov120009@yandex.ru](mailto:zhdanov120009@yandex.ru) ✉ [ok.beltyukova@yandex.ru](mailto:ok.beltyukova@yandex.ru) ✉ [nat\\_lap@mail.ru](mailto:nat_lap@mail.ru)

✉ [ludmilazdrav@mail.ru](mailto:ludmilazdrav@mail.ru) ✉ [lushchikira@yandex.ru](mailto:lushchikira@yandex.ru)

### Contribution to the literature

- Despite the importance of research on students' science anxiety, there is a lack of bibliometric studies on the current state of research on science anxiety.
- This research contributes to the literature by examining a bibliographic review of research on science anxiety in the STEM education literature.
- The results of this research provide scholars with valuable insights into various aspects of the publications, such as sources, countries of origin, authors, citations, keywords, and research topics.

Despite the ubiquity of STEM education, it is important to recognize that the existence of STEM programs does not guarantee equal access or success for all students (Garcia-Holgado et al., 2020; Idris et al., 2023). Previous research has indicated that one of the primary challenges contributing to the inequalities in education is the widespread fear of science (Gavhi-Molefe et al., 2021). Science courses often involve hands-on experimentation, abstract thinking, and the application of complex concepts in a specific field or topic. For students who struggle with science anxiety, these elements can turn the learning experience into a source of stress and anxiety.

As a result, their potential to engage, persevere, and excel in STEM subjects is compromised, perpetuating a cycle of underrepresentation and missed opportunities. Science anxiety is not a monolithic phenomenon but a complex interplay of cognitive, emotional, and behavioral factors (Henschel, 2021; Megreya et al., 2021). The cognitive aspects include the fear of failure, self-doubt, and the perception of incompetence in scientific tasks. On an emotional level, people who suffer from science anxiety struggle with feelings of apprehension and discomfort when confronted with scientific content (Megreya et al., 2021). On a behavioral level, science anxiety can manifest in avoidance of STEM-related activities, withdrawal from challenging tasks, and a decreased willingness to participate in classroom discussions or laboratory experiments (Gregg et al., 2016; Henschel, 2021).

Because of these reasons, scholars need to identify the causes of science anxiety to develop targeted measures. Experiencing higher levels of anxiety can negatively impact one's working memory, hinder information processing, and impede problem-solving skills, all of which are crucial components for succeeding in STEM fields (Gonzalez et al., 2019; Reis et al., 2014). When students face anxiety-related cognitive obstacles, they may struggle to comprehend, retain, and apply scientific knowledge (Meaders et al., 2020).

In addition, science anxiety can harm a student's academic achievement by causing a lack of self-efficacy and intrinsic motivation (Henschel, 2021; Moeller et al., 2015; Reis et al., 2014). Therefore, it is crucial to recognize both the cognitive and affective dimensions of science anxiety and develop effective strategies to alleviate it, promoting a positive STEM learning environment

(Megreya et al., 2021). Despite the importance of research on students' science anxiety, there is no bibliometric research on the state of research on science anxiety. Hence, this study aims to contribute to the literature on science anxiety by analyzing existing publications in STEM education literature. To achieve this, we conducted a bibliometric analysis to examine research resources in a specific field. This type of analysis can provide valuable insights into various aspects of the publications, such as their sources, countries of origin, authors, citations, keywords, and research topics. Analyzing the number and citations of publications is one of the most important ways to measure academic performance. This enables comparisons between different institutions, countries, authors, and journals.

### METHOD

The present study employed VOSviewer to conduct a bibliometric analysis. The findings are displayed in the format of a network diagram, illustrating the interconnections among keywords, highly referenced authors, and geographical places of science anxiety. Each term is visually depicted as a circular shape on the network map. The diameter of the circle shows the frequency of the keyword. The frequency of occurrence of a keyword is directly proportional to the size of the corresponding circle.

The spatial separation of the circles symbolizes the degree of correlation between two keywords, while the presence of a line signifies a relationship between the two keywords. Furthermore, the line in thickness indicates the frequency of their co-occurrence. This study utilized the bibliometric analysis approach along with bibliometric visualization methods. The bibliometric analysis method allows quantitative exploration of research trends and publication characteristics within a particular field (Eck & Waltman, 2010). We used VOSviewer software to collect, analyze, and visualize bibliographic data in this work.

### Data Collection

In order to collect all relevant publications related to science anxiety, a search was conducted in October 2023 in the Scopus for publications published between 2003 and 2022. To ensure the quality of the publications, we

considered articles, conference proceedings, book chapters, and books. A search keywords including "science anxiety," OR "biology anxiety," OR "chemistry anxiety," OR "physics anxiety," "anxiety toward science," OR "anxiety toward STEM," OR "STEM anxiety" was conducted in the article title, abstracts and keywords in the database.

71 publications were identified based on the search keywords. Two researchers specializing in science education conducted this search in the database. Our exclusion criterion for this study is that articles (n=2) not written in English were excluded from the bibliometric analysis. After filtering out publications unrelated to science anxiety, we had 71 relevant documents.

### Data Analysis

To reveal scientific changes and developments specific to science anxiety, this research was carried out to put scientific studies in the bibliometric analysis method. At the end of the data collection process, 71 studies were found appropriate for analysis. Distribution by years, types of publications, and languages of publications were analyzed. Then, citation analysis and how many sources the 71 studies cited in the Scopus database. The citations received by the scanned studies and the distribution of these citations according to years were evaluated. Countries conducting joint studies in science anxiety publications, journals, authors, publication co-citation networks, and concept-topic trends were examined. Social network analysis was also utilized to determine the social network analysis.

The VOSviewer software was used to determine the study's parameters. It was designed to identify emerging trends and changes in a scientific field. It is a free-access software for visualization and analysis. This application's main focus is to reveal the critical points of development. A file containing all information of 71 publications data was uploaded to the software in the appropriate format and analyzed. The country collaborations, journals, and publications cited and the network of concepts their position in the network is based on the betweenness centrality value. Betweenness centrality is a measure of a node's centrality in a network, determined by the shortest paths from all other nodes that pass through that node. A high level of betweenness centrality means that the node is important in connecting other nodes in the network. The search was subjected to a two-stage manual filtration procedure. Initially, all researchers engaged in a comprehensive review of the titles and abstracts, eliminating papers identified as irrelevant. Furthermore, the remaining literature was thoroughly examined to determine if it sufficiently satisfied the established inclusion criteria. The publications that were unrelated to science anxiety were removed from the data. **Table 1** presents the quantity of papers preserved along with

**Table 1.** Numbers of publications & their percentages according to years

Year	Number of publication	Percentage (%)
2022	6	8.4
2021	5	7.0
2020	6	8.4
2019	7	9.8
2018	4	5.6
2017	6	8.4
2016	3	4.2
2015	4	5.6
2014	7	9.8
2013	4	5.6
2012	6	8.4
2011	3	4.2
2010	2	2.8
2009	4	5.6
2008	1	1.4
2006	1	1.4
2004	2	2.8

their respective years of publication. The papers that satisfied the established criteria were subjected to the analysis.

## RESULTS

71 articles were found to be appropriate for analysis based on the inclusion and exclusion criteria. They included 59 articles, five conference proceedings, four books, two book series, and one magazine journal. **Table 1** presents the records of publications and the percentage of publications by year. The data reveals that the number of publications varies from one year to another. There has been an increase in publications from 2009 to 2022, with the highest number. Notably, there were no publications on science anxiety in 2006 and 2008. Furthermore, we excluded publications before 2003 to focus on recent trends in this area. It is also worth noting that no publication-indexed journals on science anxiety existed in 2005 and 2007.

### Keyword Analysis

Keyword analysis is a crucial bibliometric indicator. The final analysis included keywords used by authors more than five times in the Scopus database (**Figure 1**). The five most frequent keywords used in the selected articles are anxiety, science anxiety, students, self-efficacy, and education. The cluster analysis results allowed the identification of two clusters based on the 15 terms that appeared more than five times. Cluster 1 includes achievement, education, female, human, humans, male, psychology, science, student, and students; cluster 2 includes anxiety, gender, science anxiety, self-concept, and self-efficacy. These results mean researchers have focused on variables influencing students' science anxiety in two clusters.

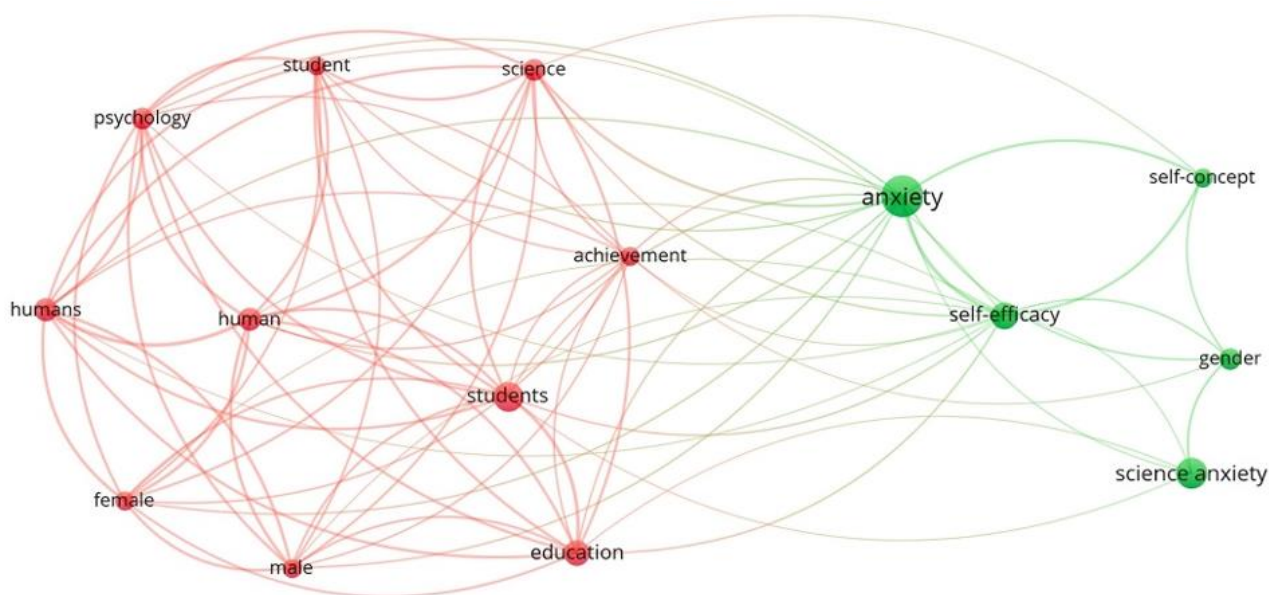


Figure 1. Keyword analysis of publications (Source: Authors’ own elaboration, using VOSviewer software)

Table 2. Top-10 publications with highest number of citations

Rank	Authors	Title	Year	Journal	DT	CCA	NC
1	Britner (2008)	Motivation in high school science students: A comparison of gender differences in life, physical, & earth science classes	2008	Journal of Research in Science Teaching	Article	USA	194
2	Udo et al. (2004)	Science anxiety & gender in students taking general education science courses	2004	Journal of Science Education & Technology	Article	USA	81
3	Mallow et al. (2010)	Science anxiety, science attitudes, & gender: Interviews from a binational study	2010	Journal of Science Education & Technology	Article	USA	51
4	Akpinar et al. (2009)	Students’ attitudes toward science & technology: An investigation of gender, grade level, & academic achievement	2009	Procedia-Social & Behavioral Sciences	Article	Turkey	47
5	Griggs et al. (2013)	The responsive classroom approach & fifth grade students’ math & science anxiety & self-efficacy		School Psychology Quarterly	Article	USA	46
6	Wan and Lee (2017)	Hong Kong secondary school students’ attitudes towards science: A study of structural models & gender differences	2017	International Journal of Science Education	Article	China	38
7	Henderson et al. (2017)	Exploring the gender gap in the conceptual survey of electricity & magnetism	2017	Physical Review Physics Education Research	Article	USA	34
8	Bryant et al. (2013)	Science anxiety, science attitudes, & constructivism: A binational study	2013	Journal of Science Education & Technology	Article	USA	30
9	Widanski and Mccarthy (2009)	Assessment of chemistry anxiety in a two-year college	2009	Journal of Chemical Education	Article	USA	29
10	Stella et al. (2019)	Forma mentis networks quantify crucial differences in STEM perception between students & experts	2019	PLoS ONE	Article	USA	28

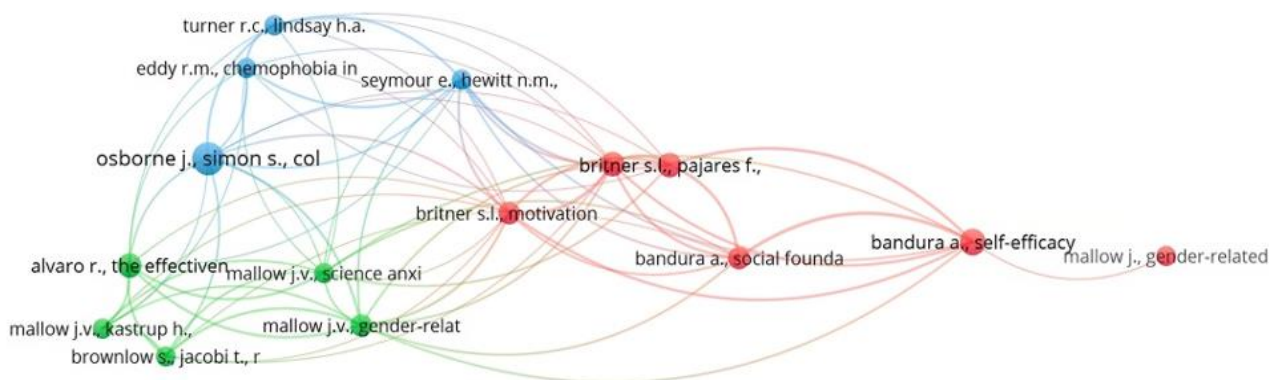
Note. DT: Document type; CCA: Country of corresponding author, & NC: Number of citations

### Top-10 Publications with Highest Number of Citations

Results show that 80% of research papers on science anxiety, which are among the top-10 highest cited publications, were conducted in the USA. The remaining studies were conducted in Turkey and China, as indicated in Table 2.

It has been proven that developed countries prioritize science education, including students’ anxiety in science and STEM education, more than underdeveloped countries. The article with the highest number of citations on science anxiety was published 15 years ago by Britner (2008).

Most of the highly cited publications focused on science anxiety and its impact on attitudes towards



**Figure 2.** Co-citation network of cited references (Source: Authors' own elaboration, using VOSviewer software)

science. In these publications, science anxiety was studied as an affective factor, which included motivation (Britner, 2008) and attitudes (Henderson et al., 2017; Wan & Lee, 2017). For example, Wan and Lee (2017) examined students' attitudes toward science. Their findings revealed four subordinate dimensions of attitudes toward science, including science anxiety. Top-10 highest-citation publications include *Journal of Research in Science Teaching*, *Journal of Science Education and Technology*, *Procedia-Social and Behavioral Sciences*, *School Psychology Quarterly*, *International Journal of Science Education*, *Physical Review Physics Education Research*, *Journal of Chemical Education*, and *PLoS ONE*. The top-10 publications with the highest number of citations are published as articles in peer-reviewed journals. Among the 10 publications, the highest was published in *Journal of Science Education and Technology*.

### Co-Citation Analysis of Cited References

We identified the most frequently cited and impactful research documents in science anxiety through co-citation analysis of cited references. Using the full counting method in VOSviewer, we obtained documents cited more than five times and discovered 15 highly cited publications. The resulting co-citation network map, shown in **Figure 2**, displays the connections between the 15 most cited references in science anxiety research in science education literature from 2003 to 2022. Each cited publication is represented by a node that includes the author and year, with circles in three colors indicating three clusters. The first cluster (red color) includes 6 documents relevant to gender motivation, self-efficacy, attitudes, and science anxiety education. Britner and Pajares (2009) studied the changes in science self-efficacy, self-concept, and anxiety among undergraduate students during introductory biology classes. The gender differences in patterns of these motivation variables were also explored. The study found that both male and female students experienced an increase in science anxiety. However, the anxiety level was higher among female students at the beginning and end of the

semester. In the second cluster (marked in green), five documents are related to gender, attitudes, science anxiety, and undergraduate students. For instance, Bryant et al. (2013) conducted a study to investigate the attitudes and anxieties of Danish and American secondary and university students toward science. They analyzed the relationships between science attitudes, science anxiety, gender, and nationality. The study revealed differences in constructivist attitudes between genders, which varied across the two cultures. The research also found that there was a connection between constructivist beliefs and science anxiety. However, the association was different for males and females and varied between the two countries. They also found that females in both countries were more science-anxious than males, and the gender differences were more significant for the Americans than for the Danes.

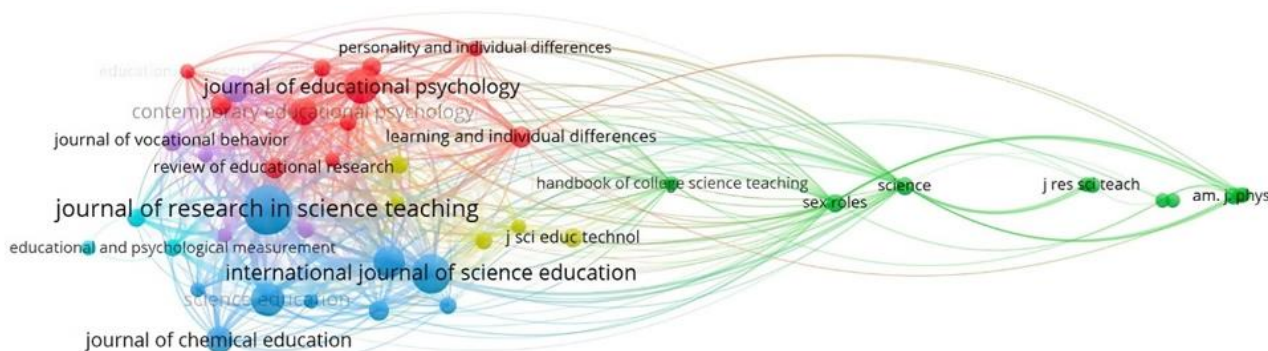
In the third cluster (marked in blue), four documents are related to achievement, attitudes, chemophobia, college students, and cognitive and non-cognitive factors. For example, Eddy (2000) conducted a study to explore chemophobia or chemistry anxiety among college students. The study found that, on average, chemophobia ranged between a little bit and moderate. The highest level of anxiety was associated with chemistry evaluation, while the lowest was associated with learning chemistry. The main sources contributing to chemistry anxiety were learning chemical equations, taking the final exam for evaluation, and handling chemicals, particularly the fear of getting chemicals on one's hands. The study also found that women had significantly higher anxiety levels than men, and students with less experience in chemistry had significantly higher levels of anxiety than those with more experience.

### Co-Citation Analysis of Publication Sources

The purpose of co-citation analysis of publishing sources is to identify the peer-reviewed journals that cite research on science anxiety. **Table 3** presents the top-10 most cited published sources in the VOS viewer dataset, listed in descending order. Our co-cited research groups

**Table 3.** Top-10 journals placed in co-citation analysis of publication sources

Rank	Journals	Citations	Links
1	Journal of Research in Science Teaching	115	2,561
2	Journal of Educational Psychology	57	1,483
3	International Journal of Science Education	74	1,411
4	Science Education	53	1,117
5	Journal of Counseling Psychology	35	981
6	Journal of Science Education and Technology	49	979
7	Contemporary Educational Psychology	36	879
8	Learning and Individual Differences	23	610
9	Journal of Vocational Behavior	20	589
10	Journal of Chemical Education	36	535



**Figure 3.** An analysis of co-citation network of publication sources (Source: Authors’ own elaboration, using VOSviewer software)

43 publications with more than 10 citations into six categories, including educational psychology research (red line), physics education research (green line), science education research (blue line), science education and psychology (yellow line), vocational research (purple line), and chemistry anxiety research (turquoise color).

We discovered some educational psychology research journals, such as Journal of Educational Psychology, Journal of Counseling Psychology, Contemporary Educational Psychology, Learning and Individual Differences, and Journal of Vocational Behavior. We also found science education journals, including Journal of Research in Science Teaching, International Journal of Science Education, Science Education, Journal of Science Education and Technology, and Journal of Chemical Education. Namely, half of the publications were published in peer-reviewed journals that published articles in the science education field. The rest was published in educational psychology research journals. In particular, science education journals, where articles were published on science anxiety were often considered by researchers to be core publication sources in science education research.

Figure 3 shows one of the most important clusters (cluster 3, blue line) of publication sources as being related to science anxiety, as well as a significant linkage between the sources, the publications of which include Journal of Research in Science Teaching, International

Journal of Science Education, Science Education, Journal of Science Education and Technology, and Journal of Chemical Education, Research in Science Education, Journal of Baltic Science Education, School Science, and Mathematics, and American Journal of Physics.

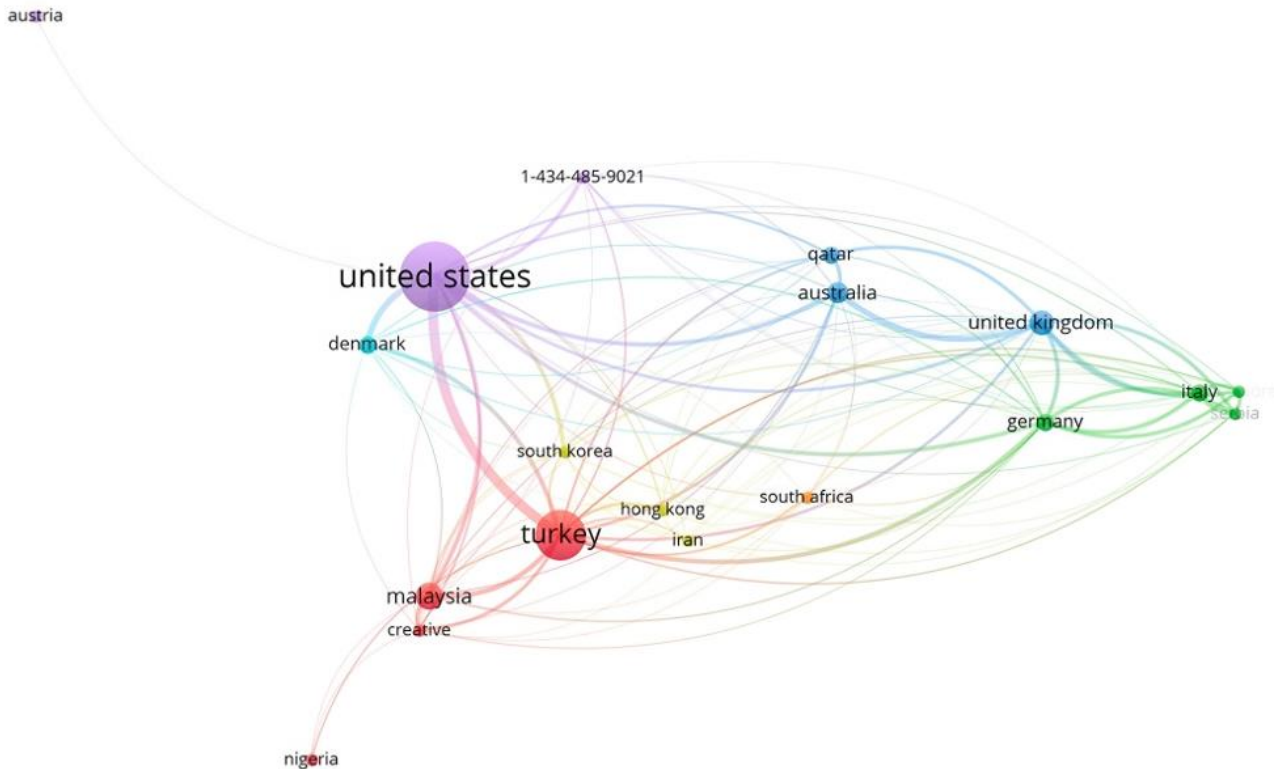
In addition, several publication titles, including American Educational Research Journal, Contemporary Educational Psychology, Educational Assessment, Educational Psychologist, Journal of Educational Psychology, Learning and Individual Differences, Personality, and Individual Differences, Psychological Reports, Review of Educational Research, Journal of Educational Research (see cluster 1, red line) have served as a link between the clusters of science education and psychology research.

**Bibliographic Coupling of Authors**

Table 4 presents the bibliographic coupling of the authors. To be included in the analysis, each author must have at least three publications and citations. Based on this criterion, 10 authors were found to be included in the bibliographic coupling analysis. The first author was S. L. Britner, who had five publications, 221 citations, and 3568 link strength. Authors have three metrics: publications, citations, and link strengths. These metrics are given respectively in the parentheses. The other authors are L. I. Carruth (3; 25; 3,384), R. I. Dehaan (3; 25; 3,384), M. K. Demetriokopoulos (3; 25; 3,384), K. J. Frantz (3; 25; 3,384), C. T. Goode (3; 25; 3,384), J. I. Pecore (3; 25; 3,384), B. A. Williams (3; 25; 3,384), N. I. Kurbanoglu (3;

**Table 4.** Bibliographic coupling of authors

Rank	Authors	Documents	Citations	Links
1	S. L. Britner	5	221	3,568
2	L. I. Carruth	3	25	3,384
3	R. I. Dehaan	3	25	3,384
4	M. K. Demetriokopoulos	3	25	3,384
5	K. J. Frantz	3	25	3,384
6	C. T. Goode	3	25	3,384
7	J. I. Pecore	3	25	3,384
8	B. A. Williams	3	25	3,384
9	N. I. Kurbanoglu	3	25	199
10	M. Sahranavard	4	11	181



**Figure 4.** Bibliographic coupling of countries (Source: Authors’ own elaboration, using VOSviewer software)

25; 199), and M. Sahranavard (4; 11; 181). These results show that the research team of S. L. Britner and L. I. Carruth and colleagues authored the most publications in the area of science anxiety.

**Bibliographic Coupling of Countries**

In **Figure 4**, we see how countries are connected through bibliographic coupling. Only countries with at least one publication were included in this analysis; out of the 24 countries, 19 met the threshold. We calculated the total strength of bibliographic coupling links for each country concerning the other countries. The USA came out on top with 32 publications, 663 citations, and a link strength of 1,053, significantly higher than the other countries. Authors have three metrics: publications, citations, and link strengths. These metrics are given respectively in the parentheses. The other countries were Turkey (17; 130; 965), United Kingdom (4; 47; 522),

Germany (2; 33; 470), Australia (3; 33; 333), Italy (2; 37; 293), Malaysia (5; 15; 287), Denmark (2; 81;263), Serbia (1;28;258), and Singapore (1; 28; 258). England, Italy, Netherlands, Spain, and Israel have the most recent publications in this research topic.

**DISCUSSION**

The present study employed a bibliometric analysis methodology to investigate and examine scientific anxiety publications within the existing research literature. For this purpose, the Scopus database was searched and used. The bibliographic data was analyzed using the VOSviewer. Keyword analysis, co-citation analyses of publications and sources, and bibliographic coupling of the authors and countries were analyzed. Keyword analysis showed that the selected articles’ five most frequently used keywords are anxiety, science anxiety, students, self-efficacy, and education. The

cluster analysis results allowed the identification of two clusters based on the 15 terms that appeared more than five times. Cluster 1 includes achievement, education, female, human, humans, male, psychology, science, student, and students; cluster 2 includes anxiety, gender, science anxiety, self-concept, and self-efficacy. These results mean researchers have focused on variables influencing students' science anxiety in two clusters. It has appeared from the results that the research on learners' science anxiety has focused mostly on science anxiety, achievement, self-concept, and self-efficacy.

Regarding the top-10 publications with the highest citations, the results showed that 80% of research papers on science anxiety, among the top-10 highest cited publications, were conducted in the USA. The remaining studies were carried out in Turkey and China. The research findings reveal that science education is more important in developed countries than in underdeveloped ones. It was found that students' anxiety around science and STEM education was a major concern. The majority of the highly cited publications focused on science anxiety and how it affects attitudes toward science. Science anxiety was studied as a part of affective factors, which also included motivation. The top-10 publications with the highest number of citations include *Journal of Research in Science Teaching*, *Journal of Science Education and Technology*, *Procedia-Social and Behavioral Sciences*, *School Psychology Quarterly*, *International Journal of Science Education*, *Physical Review Physics Education Research*, *Journal of Chemical Education*, and *PLoS ONE*. All these publications are peer-reviewed journals. Among the top-10 publications, the most articles were published in *Journal of Science Education and Technology*. All of these journals are well-known journals that have published articles for a long time in science education and educational sciences literature.

The results of the co-citation analysis of cited references revealed three clusters. The first cluster included six documents relevant to gender motivation, self-efficacy, attitudes, and science anxiety education. The second cluster comprised five documents related to gender, attitudes, science anxiety, and undergraduate students. In the third cluster, four documents were related to achievement, attitudes, chemophobia, college students, and cognitive and non-cognitive factors. These students show that research on science anxiety has focused on three clusters. Co-citation analysis of publishing sources revealed six clusters. The results showed that the researcher cited educational psychology research journals, such as *Journal of Educational Psychology*, *Journal of Counseling Psychology*, *Contemporary Educational Psychology*, *Learning and Individual Differences*, and *Journal of Vocational Behavior*, in research on science anxiety. In addition, science education journals, including *Journal of Research in Science Teaching*, *International Journal of*

*Science Education*, *Science Education*, *Journal of Science Education and Technology*, and *Journal of Chemical Education*, were cited in the science anxiety research. Namely, the results indicated that half of the publications also used psychology education journals. The bibliographic coupling of the authors showed that research teams from the USA authored the most publications on science anxiety. The results regarding the bibliographic coupling of countries revealed that the USA came out on top with 32 publications, 663 citations, and a link strength of 1,053, significantly higher than the other countries among 24 countries. The other following countries were Turkey, the United Kingdom, Germany, Australia, Italy, Malaysia, Denmark, Serbia, and Singapore, respectively.

Science anxiety has garnered the attention of numerous scientists worldwide. However, the results show that scholars from the USA have been particularly interested in this topic. This finding is evident because the USA leads all countries regarding the number of publications, citations, and link strength in this field. Additionally, most of the authors in this field are from the USA. Therefore, it can be inferred that the USA has the strongest institutions regarding quality and quantity, which may explain the reasons behind these results. Another potential factor could be the presence of attitudes within the USA culture that contribute to the development of science anxiety. The considerable attention given to scientific anxiety among researchers in the USA may be attributed to their attempts to address this prevalent issue nationally. Science anxiety is a common issue experienced by students in science classrooms worldwide. It is being widely investigated as a major cause of underachievement in science (Kaur & Vadhera, 2021). Modern society has been facing increasing problems in science and STEM education. Researchers worldwide have conducted numerous scientific studies to tackle this issue (Smolyaninova & Popova, 2019). The study's findings offer valuable insights for educators and policymakers and contribute to the existing literature on science anxiety.

## CONCLUSIONS

The research trend in science anxiety has been analyzed by examining the Scopus database. The characteristics of research literature on students' science anxiety through bibliometric methods were analyzed. This study conducted a citation and co-citation analysis of 71 articles on science anxiety, providing valuable insights into science and STEM education. We found that the number of science anxiety studies has slightly increased due to the development of STEM education and international trends emphasizing the importance of STEM education research. This study is useful for accessing publications on science anxiety and identifying the research direction of science anxiety in



science education. The results show a close relationship between science education and educational psychology journals. The research used terms such as anxiety, science anxiety, students, self-efficacy, and education frequently while discussing science anxiety research. The knowledge gained from this research can help educators achieve better results. The results of this study can guide future STEM education research for researchers and policymakers to contribute to the research literature about learners' science anxiety in the future. We have contributed to the existing body of literature by conducting a comprehensive review of the current state of research in this area. Our review has identified the most productive sources, research directions of the last decade, and the network of sources, authors, references, and keywords that link different aspects of this productivity.

### Recommendations

A paradigm shift in pedagogical approaches is essential to address the general problem of science anxiety. Traditional methods that emphasize memorization and standardized assessments may inadvertently contribute to anxiety by promoting a narrow view of success for divergent thinking. In contrast, integrative pedagogical approaches emphasizing active learning, collaborative problem-solving, and real-world applications have shown promise in reducing science anxiety. By incorporating diverse examples, encouraging a growth mindset, and emphasizing the relevance of scientific concepts to everyday life, educators can contribute to a positive change in students' perceptions of science. In addition, integrating mentorship programs and exposure to diverse STEM professionals can help break down stereotypes and build confidence in students from underrepresented groups. While educators play a central role in shaping the classroom environment, the responsibility for combating science anxiety is with educational institutions and policymakers. Institutions must prioritize implementing evidence-based practices that promote student mindsets regarding science courses. This includes providing resources for teachers' professional development to build an open dialog about anxiety and foster a culture of inclusivity that values diversity in STEM. Policymakers should work with educators and researchers to advocate to reduce learners' science anxiety to encourage them to have a career in science disciplines. This includes revising the availability of resources for underserved schools and actively working to reduce challenges that contribute to perpetuating science anxiety. In addition, research on the effectiveness of interventions and the long-term impact of inclusive practices can provide evidence-based strategies to decrease learners' science anxiety and promote them in a more equitable STEM landscape. Another suggestion is that universities in the USA are

the most productive organizations, and the USA is the most productive region. Our findings demonstrate the significant contribution of researchers from the country. The USA is expected to continue to play a leading role in advancing research in this area.

### Limitations

Every research is conducted within a specific scope and limitations. The most important limitation of the study is that the data analyzed is only from the Scopus database. This study does not include other databases, such as EBSCO, ERIC, and Web of Science. Therefore, there may be a particular issue for future studies to consider this limitation.

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**Ethical statement:** The authors stated that the study did not require ethics committee approval since it is based on existing literature.

**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.

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