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Anxiety and Self-Efficacy of Teachers in STEM Literature: A Scoping Review

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Abstract: With the increasing inclusion of STEM activities across the K–12 curriculum, it is vital for educators to understand barriers and resistance to learning each of the elements of STEM: science, technology, engineering, and math. Anxiety and self-efficacy for students and teachers have been identified as causes of STEM avoidance; however, this research is not distributed evenly across the elements. Therefore, this study documents potential causes for anxiety of each element, followed by a scoping review for each element of STEM-focused teacher anxiety, one of the major causes of STEM anxiety. The scoping review was guided by PRISMA standards and completed twice: once in Educational Resources Information Center and once in Scopus, with results demonstrating 94%–100% inter-rater reliability. It was found that causes of anxiety differ between the elements, and the scoping review revealed: (1) research on engineering anxiety and i-STEM or integrated STEM is lacking in comparison to the other elements, (2) the term "anxiety" is more established in reference to math than to the other elements, (3) technology appears in research as a tool more often than an area of research, and (4) the timeline of publication dates varies between the elements of STEM. These differences point to the need for more research in the underrepresented elements to develop intervention methods for teachers in order to reduce student attrition rates in STEM education.

Keywords: STEM, anxiety, self-efficacy, scoping review, education, integrated STEM

1. Introduction

A teacher's ability to impact learning is affected by numerous factors, such as student responses, external pressures, and their own confidence levels. When a teacher is confident and passionate about the content they are teaching, it gives a positive perspective to the pupils. The inverse is also true; if a teacher is unsure or defensive, students absorb the nervousness about the subject (Coladarci, 1992; Gibson & Dembo, 1984). Especially for science, technology, engineering, and math (STEM) concepts, a teacher's anxiety can affect the students' confidence with the material (Martinez, 1987). A concept related to anxiety is self-efficacy, defined as a person's belief of their capabilities to perform tasks (Bandura, 1995). Teachers' self-efficacy has also been given attention in research because of its effect on student engagement and learning (Coladarci, 1992). While high anxiety and low self-efficacy of teachers both affect student performance (Hsieh et al., 2012), anxiety has more direct physiological effects (Spielberger, 1972).

Anxiety and self-efficacy affect students as well as teachers. Student attrition rates in K–12 STEM education are visually represented by the "pipeline," which describes the lack of professionals in the STEM fields due to students dropping out of the STEM career path during their schooling (Epstein, 2006; McCoy, 2019). The pipe represents the path to a career in a STEM field, and the holes in it represent the students who drop out along the way. The lack of students in STEM is urgent as the world needs STEM professionals.

Additionally, it is important for the general public to have a base-level knowledge of STEM in order to participate in STEM-related decision-making (Albion et al., 2016; Mallow, 1981), for example, climate change, sustainable energy practices, and vaccinations. With the example of the COVID-19 pandemic, public health officials are responsible for providing details on the emerging situation, but without basic knowledge of the body's immune system, it is hard for individuals to make informed decisions. If students disengage with STEM by high school, they will not only be removed from the STEM career path, but they will not have the knowledge necessary for informed decision-making. They may rely on potentially biased or inaccurate information from the media and other sources. Thus, the effects of STEM attrition are seen throughout society.

There is a cycle of anxiety in education systems. Teachers' STEM anxiety affects their teaching and subsequently their students, who can inherit the anxiety, avoid subjects, and dismiss STEM as a career path. Additionally, preservice teachers who felt STEM anxiety in their K–12 education retain and consequently pass it on to their students (Coladarci, 1992; Gibson & Dembo, 1984; Martinez, 1987), continuing the cycle.

A review of the literature reveals that researchers focus on single STEM elements, referring to individual subjects such as science, technology, engineering, or math. However, a comparison of anxiety research across the elements has not yet been performed. There may be differences in causes and manifestations of anxiety for the different elements, which are not yet apparent.

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Additionally, there may be acute differences in the quantity of research on the anxiety of teaching the different elements of STEM.

This paper seeks to help STEM educators and researchers to recognize barriers to learning, which can in turn improve overall STEM pedagogy. Focusing specifically on anxiety as a barrier to learning, this paper is divided into two sections. Part 1 provides an overview of anxiety research in the individual elements of science, technology, engineering, and math, followed by a review of integrated STEM (or i-STEM). While investigating the first part, we realized that more research has been devoted to anxiety in math and science fields, with few studies documenting anxiety in engineering or i-STEM. When we expanded our search to include self-efficacy, a term which was often paired with anxiety, there was more information available; however, it was still limited for the engineering. Also, because teacher anxiety has a direct effect on student learning (Coladarci, 1992; Hsieh et al., 2012), part 2 contains a scoping review of the literature on anxiety and self-efficacy of teachers, looking across the four STEM elements to compare the prevalence of the two terms.

This study fills a gap in the literature to examine whether sufficient research is being devoted to anxiety in teachers across the STEM elements. If there is saturation in one of the elements, then those resources should be devoted to examining anxiety in a different element or in i-STEM. In this study, we explore: (1) What does the literature state about STEM anxiety for each element and collectively for i-STEM? (2) Is the amount of research on teacher's anxiety or self-efficacy comparable across the STEM elements?

2. Literature Review

This section contains background information on the relationship between anxiety and self-efficacy. The two concepts are often linked (Mels et al., 2023; Shahrbabaki et al., 2023; Živković et al., 2023); however, they have distinct and yet inverse meanings.

Anxiety has many definitions, but for this paper, "anxiety is most often used to describe an unpleasant emotional state or condition which is characterized by subjective feelings of tension, apprehension, and worry, and by activation or arousal of the autonomic nervous system" (Spielberger, 1972). Anxiety is a cognitive state that is linked to negative emotions such as feelings of incompetence, fear, or being perceived as unintelligent (Maurer, 1983; Porto Bellini et al., 2016). It is essentially worry for what may happen or how one is perceived. This state of uncertainty could erode self-confidence or well-being, particularly in new situations such as when one is introduced to new technology or a STEM activity.

Whereas anxiety can be perceived as negative and fear-based, self-efficacy has positive connotations and denotes confidence. According to Bandura (1995), self-efficacy is belief in one's ability to complete a task. It relates how well one can overcome barriers and meet goals (Shahrbabaki et al., 2023). For example, a student with high self-efficacy feels they can tackle challenges and are more confident for new activities. This influences their emotional state and is less likely to be anxious (Živković et al., 2023). The inverse has been shown to be true as well; low self-efficacy is negatively correlated with high anxiety (Shahrbabaki et al., 2023; Živković et al., 2023).

Studies disagree about which is the antecedent or whether they are simultaneous processes (Porto Bellini et al., 2016). While anxiety also refers to the body's physical response to a situation, where feelings of anxiety extend beyond the purely cognitive state to include physiological and behavior tension (Mels et al., 2023; Spielberger, 1972), self-efficacy is rooted in an individual's beliefs about themselves (Bandura, 1995). This indicates that anxiety is a broader term than self-efficacy. Alternatively, Bandura (1995) states that one of the ways people judge their own capabilities is by evaluating their physiological and emotional states. Therefore, sensing anxiety in response to a situation reduces self-efficacy, which indicates that self-efficacy is a term that encompasses the effects of anxiety. Though there is some disagreement as to the relationship for the purposes of this study, it is clear that self-efficacy and anxiety are related concepts. With so few studies focused on anxiety in STEM, broadening the search to include self-efficacy provides more information to compare research quantity across the STEM elements.

3. Research Methodology

This section focuses on the methodology of part 2 of the study: the scoping review. The purpose of a scoping review is to scan the literature, provide an overview, identify gaps, and highlight commonalities. Unlike a systematic literature review, which seeks to answer a specific question and synthesize the research, a scoping review investigates the volume and focus of research to develop appropriate questions for future research (Munn et al., 2018). Also, a scoping review is intended to be iterative and the starting point to build a framework on in future studies (Sannicandro et al., 2022).

The methodology of this scoping review was developed from Tricco et al. (2018). Educational Resources Information Center (ERIC), used through EBSCOhost, was chosen as our primary database because it is focused on the education discipline. Results from searches in ERIC were verified with searches in Scopus and triangulated by two reviewers. We focused on teachers as the subject of the review due to the cyclical nature of anxiety, as improving teachers' anxiety levels will impact students.

We analyzed only peer-reviewed academic literature (academic journals in ERIC and articles in Scopus), excluding conference materials to ensure rigor. Searches were limited to the title of the document rather than full-text searches to ensure more accurate results. The most recent search was executed on August 2, 2021, while that in Scopus was executed on August 3, 2021. Two search phrases were used, each performed with the four STEM elements (Table 1). Since computer science is part of the T in STEM, we included it in the search with the term technology. The asterisk after "Math" indicates that searches include results from any term that has the beginning "math," such as "maths" or "mathematics." The second search phrase, "___ AND anxiety AND teachers," omits the term "self-efficacy." We chose this phrase because we noted that several results from the math search used the term "anxiety," while in other searches "self-efficacy" was more prevalent. The full searches are shown in Appendix.

ERIC results were independently screened for relevance by the coauthors and compared to increase in reliability of the results. Inter-rater reliability was 94%, 99%, 100%, and 96% for science, technology, engineering, and math, respectively. Figure 1 shows the number of articles identified in the ERIC results, organized for each STEM element. Results were assessed for eligibility and articles were excluded if they concerned a different element than the search phrase. Secondly, articles referring only to the anxiety of students rather than teachers were excluded. Several articles that investigated the effects of teacher behavior on students were included due to their relevance to teacher self-efficacy and anxiety. Additionally, documents referring to teachers' Technological Pedagogical Content Knowledge (TPACK) were included, since content knowledge is a portion of the TPACK framework.

After the screening process, article counts were recorded and percentages were calculated based on the total number of articles

Table 1
Search terms and phrases

Element term	Search no.	Phrase
Science Technology OR "computer science"	1	________ AND (anxiety OR self-efficacy) AND teachers
Engineering Math*	2	________AND (anxiety) AND teachers

Figure 1
Inclusion/exclusion flowchart of articles per element for search 1: Anxiety or self-efficacy

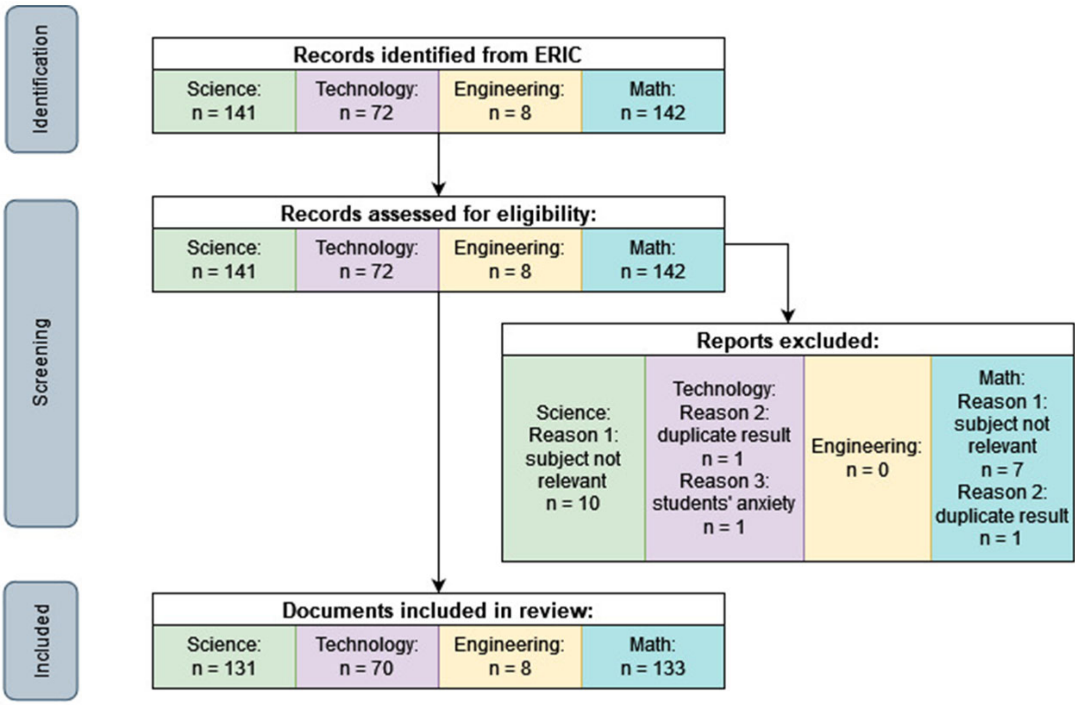


Table 2
Comparison of non-screened results in ERIC and Scopus for search 1: Anxiety or self-efficacy

	ERIC		Scopus	
	No.	%	No.	%
Science	141	41%	129	38%
Technology	72	21%	62	18%
Engineering	8	2%	10	3%
Math	142	41%	142	41%
			Correlation:	93%

Table 3
Search results by element

	Search 1: Anxiety OR self-efficacy		Search 2: Anxiety	
	No.	%	No.	%
Science	131	38%	12	14%
Technology	70	20%	5	6%
Engineering	8	2%	0	0
Math	133	39%	71	81%
Total	342		88	

across all elements (Tables 2 and 3). Secondly, it was noted whether documents investigated a specific education level, whether at the primary, middle, secondary, or K–12 level (Table 4). The grade range of middle school was not identical across documents, and occasionally the primary or secondary levels encompassed middle school grades. Thirdly, the subject of each article was recorded as either in-service, preservice, or both. For technology, the results were delineated into additional categories (Table 5). Lastly, the publication dates of articles from the first search were graphed cumulatively, where articles from 2021 were excluded to avoid misleading trends (Figure 2).

4. Results Part 1: Anxiety in Each Element

This section responds to question (1) What does the literature state about STEM anxiety for each element and collectively for i-STEM? In short, we found that science anxiety is often based in external pressures such as academic performance and the conceptual divide between science and society. Technology anxiety is varied due to varying definitions and uses of technology in the classroom. Teachers' unpreparedness to teach engineering affects their anxiety levels. Math anxiety can arise from the use of authoritarian teaching styles and negative past experiences.

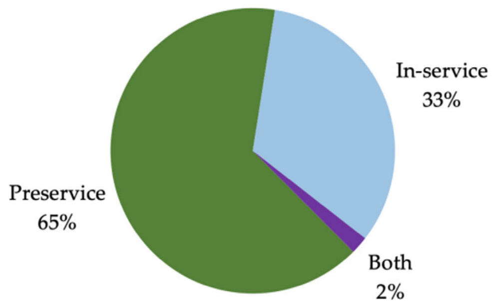
Table 4
Targeted education level of studies for search 1: Anxiety or self-efficacy

	Science		Technology		Engineering		Math	
	No.	%	No.	%	No.	%	No.	%
Primary	72	80%	11	39%	6	75%	71	72%
Middle	10	11%	2	7%	0	0	10	10%
Secondary	7	8%	10	36%	1	13%	6	9%
K–12	1	1%	5	18%	1	13%	6	9%
Subtotal*	90		28		8		93	

Table 5
Technology usage across documents for search 1: Anxiety or self-efficacy

	No.	%
Learning outcome, element of STEM (1)	16	23%
Educational tool (2)	8	11%
Integrated into other subjects (3)	46	66%
Subtotal	70	

Figure 2
Graph of articles by year for search 1: Anxiety or self-efficacy



4.1. Historical context

The historic prevalence of the terms "science anxiety," "technology anxiety," "engineering anxiety," and "math anxiety" differs greatly, even when considering literature with a broader focus, such as anxiety related to medicine and non-STEM professionals. In 1954, Gough (1954) coined the term "mathemaphobia" in a report on issues she observed in her classroom. Dreger and Aiken (1957) wrote a paper on "number anxiety," finding that it was separate from general anxiety. Several other works investigated math anxiety in 1977 (Betz, 1977; Hendel, 1977), and in 1978, Tobias wrote "Overcoming Math Anxiety," which was one of the first to use the term "math anxiety" (Tobias, 1995). In the same year, the term "science anxiety" appears in separate articles by Mallow (1978) and Greenberg (1978). The term "technology anxiety" appears several years later in Pillar (1985). The term "engineering anxiety" returns very few results, most of which are not related to the topic and are instead concerned with topics such as the engineering profession (Korkut et al., 2011; Woodin, 2019), engineering students' perception of their professional future, and engineering students' anxiety of other subjects (Soneira & Mato, 2020). However, one result that uses the term "engineering anxiety" was published in 2020 and focused on methods of improving engineering thinking and reducing engineering anxiety in deaf students (Allah et al., 2020). The lack of documents using the term "engineering anxiety" indicates that it is not yet well established in literature. Similarly, no instance found that discusses anxiety in i-STEM.

4.2. Science

Greenburg and Mallow (1982) found that college student experiences with science anxiety often involve a student coming across a difficult problem, experiencing anxious thoughts, then doubting themselves, and becoming worried about not performing well in the class. These "irrational thoughts" hinder the students' ability to move past the difficult problem. Avoidance of science is another effect of science anxiety and is evident in students who take only the minimum number of science courses required for their degree (Mallow, 1981). Students with science anxiety avoid asking the professor questions and may panic during exams, performing poorly as a result (Mallow, 1981). Adult college students reported feeling pressure to pass science courses to earn their degree without wasting time or resources (Hinds, 1999).

Students' beliefs about science affect their science anxiety (Bryant et al., 2013). There has been a widespread belief in the existence of a scientific mind versus a humanities mind (Anderson & Clawson, 1992; Mallow, 1981; Sanstad, 2018). The divide between science and society has a historic element to it, as Sanstad (2018) posited that scientists stopped giving lectures to the public in the 1930s in order to spend more of their time on research. Without opportunities for non-STEM professionals to understand the discoveries being made, society became detached from science.

Anderson and Clawson (1992) explain another reason teachers can affect student STEM learning. If the instructor understands difficult scientific concepts easily, their demeanor can lead students to believe that if they do not understand as easily as their teacher, they are not well suited to science. Furthermore, it is difficult to pick up a scientific article and understand it, whereas you can understand a poem or artwork by spending time with it (Mallow, 1981). The terminology and concepts of scientific articles are unknown to those who have not studied the field, which further distances the public from science knowledge and can impact science anxiety. As there are cases where an introductory college course in biology required students to learn more new terminology than a foreign language course, the effect of anxiety due to difficult terminology is substantial (Anderson & Clawson, 1992).

One final cause of science anxiety is that negative past experiences with science (Bryant et al., 2013; Hinds, 1999; Mallow, 1981) can have long-term effects on students. Failing a course, an intimidating teacher, new terminology, or struggling with concepts could cause students to avoid taking science in the future and ultimately dismissing STEM as a career option.

4.3. Technology

Though definitions vary, this paper defines technology as the tools developed using STEM concepts with the goal of impacting the world in a positive way (American Association for the Advancement of Science, 1993; Chai et al., 2019; International Technology Education Association & Technology for All Americans Project, 2000). There are also several ways technology is used in education: (1) taught as a subject with learning outcomes, such as word processing or computer programming, (2) used as an educational tool (Hannafin & Peck, 1988), such as using slides to present other material, or (3) integrated into other subjects (Chai et al., 2019), such as physical education (Krause, 2017). Computer-assisted instruction, defined as the use of computers to deliver instructional content, is an example of technology as an educational tool (Hannafin & Peck, 1988). Similarly, articles refer to "computer anxiety" (Chua et al., 1999; Galagan, 1983; Powell, 2013; Scott & Rockwell, 1997; Venkatesh, 2000) as "the fear or apprehension felt by an individual when using computers, or when considering the possibility of computer utilization" (Maurer, 1983). Computer anxiety is often used in the context of the general public (Galagan, 1983), as well as with reference to technological advancements in medicine (Kjerulff et al., 1992; Pillar, 1985).

Stereotype threat, the fear of confirming a negative stereotype, is linked to technology anxiety (Steele & Aronson, 1995). For example, a female student taking computer science worries because the subject is stereotypically connected to men, which impedes her performance (Eschenbach et al., 2014). Research into stereotype threat in computer science education conducted by Cheryan et al. (2013), Dou et al. (2020), Pantic et al. (2018) and Schorr (2019) has shown that stereotype threat can affect students as early as Grade 6 (Good et al., 2008). Stereotype threat is a barrier to pursuing careers in STEM fields, especially in technology.

4.4. Engineering

A common cause of engineering anxiety is a lack of preparedness to teach engineering (Hammack & Ivey, 2017; Kang et al., 2018). In a study of 7,752 teachers in the USA, only 1% were exposed to engineering education in college (Banilower et al., 2013). While 73% of K–6 teachers felt unprepared to teach engineering, less than 10% felt unprepared to teach the subjects language arts, math, social studies, science, life science, earth science, and physical science (Banilower et al., 2013). Similarly, the National Research Council et al. (2009) found that there was no license or certification required for teaching engineering, but there were for other subjects such as science, math, and technology. This suggests that those teaching engineering have not received the same level of training as those teaching science or math.

Another reason for teachers' unpreparedness is that engineering is a recent addition to school curricula in comparison to other subjects (National Research Council et al., 2008). For example, in the late 1990s, a longitudinal international study was carried out on students' math and science performance, but there was no mention of engineering (National Research Council et al., 1999). As engineering is only beginning to appear in curricula, now is an ideal time to investigate engineering anxiety.

4.5. Math

Math anxiety is defined by Deniz and Üldaş (2008) as "an irrational dread of mathematics that interferes with manipulating numbers and solving mathematical problems within a variety of everyday life and academic situations" and is common in teachers (Bekdemir, 2010; Kelly & Tomhave, 1985). Math anxiety has been given attention from researchers for decades, and consequently, the body of literature on math anxiety is extensive and detailed. There are established theories that describe it, including deficit theory, debilitating anxiety model, and social cognitive theory (Brewster & Miller, 2020; Carey et al., 2016). Additionally, factors of math anxiety include social, cognitive, genetic, and missed opportunities (Brewster & Miller, 2020).

College students who major in elementary education have the highest rates of math anxiety (Baloğlu & Koçak, 2006; Hembree, 1990; Kelly & Tomhave, 1985). When preservice teachers with math anxiety have their own classrooms, they often pass on the anxiety to their students (Martinez, 1987). One cause of math anxiety is previous negative experiences with math (Cornell, 1999; McMinn, 2018; Reyes, 1984), often associated with specific teachers or teaching styles used in math classrooms (Bekdemir, 2010; Reyes, 1984). Hilton (1980) explains that causes of math anxiety include emphasis on drill work and memorization, problems lacking relevance to the real world, using an authoritarian style of teaching, and tests.

Ball (1990) found three misconceptions about preparation for math teaching: that elementary school math is easy, that preservice teacher education in math is adequate, and that majoring in math guarantees you have enough knowledge to teach math.

4.6. Integrated STEM or i-STEM

From the literature, we see various causes of anxiety of teaching science, technology, engineering, and math. Just as each element of STEM anxiety has different causes, anxiety can exist when considering STEM as a whole (Chai et al., 2019). Integrated STEM (i-STEM) is the teaching of STEM concepts in a cohesive way, such that each element complements the others. These concepts include engineering design, applied math and science, technology, and social awareness (Honey et al., 2014). Although the term was defined in 2014, little literature exists on teachers' anxiety for i-STEM. Documents often include the term "STEM" when referring to research within one of the STEM fields (Ayuso et al., 2021; Boulden et al., 2021; Ofem et al., 2021), so research on i-STEM is just beginning to emerge. A 2023 study on attitudes toward i-STEM indicates that teachers who are open to adaptive and innovative strategies are more likely to embrace i-STEM teaching (Saleh et al., 2023). Because curricula are moving toward adopting i-STEM, particularly through project-based learning (Prince Edward Island Department of Education, 2018), there is a need to research anxiety related to its adoption and inclusion.

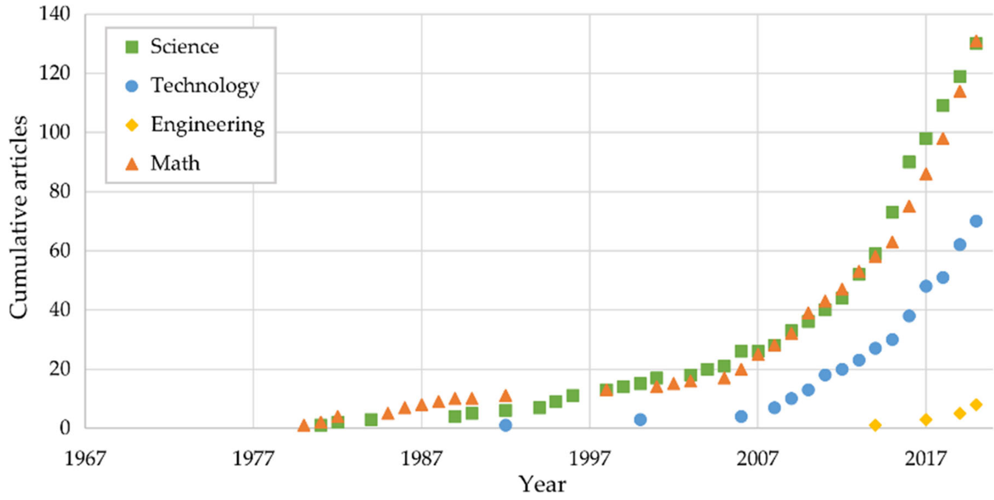
5. Results Part 2: Anxiety and Self-Efficacy of Teachers Across the STEM Elements

This section addresses the second question: Is the amount of research on teacher's anxiety or self-efficacy comparable across the STEM elements? Though we would prefer to focus this study solely on anxiety, in order to have meaningful data, we broadened the search to include self-efficacy and narrowed the search to teachers' anxiety and self-efficacy. Similarly, we would have like to include i-STEM in the scoping review, but a dearth of research at the time of the review prevented its inclusion.

The correlation between non-screened results in ERIC and Scopus was 93% as shown in Table 2. Therefore, ERIC results were confirmed and used for the remainder of this review.

Table 3 demonstrates that the search using engineering as the element term yields fewer results than the search for science,

Figure 3
Location of research for all articles for search 1: Anxiety or self-efficacy



math, or technology. Engineering represents only 2% of the total number of results, where technology represents 20%, and science and math have similar values of 38% and 39%, respectively. Recall that Figure 1 detailed reasons for the exclusion of 20 papers between Tables 2 and 3.

There is a clear difference between using a search phrase that requires "anxiety" or "self-efficacy" and one that requires "anxiety." Search 1 for science, technology, and engineering yielded more results than search 2 for each element. However, when comparing results in search 1 and 2 for math, approximately half of the articles use the term "anxiety" in the title. Additionally, 81% of the search 2 results across the four elements are found in math. These results indicate that the phrase "anxiety" is more established in math than in other elements.

As shown in Figure 3, across all STEM elements, 65% of documents focused on preservice teachers' anxiety, 33% on in-service, and 2% on both preservice and in-service.

As shown in Table 4, research focuses on education at the primary level. Of papers that specified a level of education, 70–80% of papers in science, engineering, and math focused on the primary level. However, for technology, 39% of papers focused on the primary level, and 36% on the secondary level. Overall, the high percentages of papers referring to primary education suggests that research is more focused on the primary level than middle, secondary, or K–12.

Additionally, it was noted that the documents under technology referred to technology in education in different ways. The documents were grouped according to these definitions, as shown in Table 5. Technology integration represented 66% of results, teaching technology as an element of STEM represented 23%, and students (including preservice teachers) using technology to learn represented 11%.

Figure 2 demonstrates that there are fewest results for engineering (yellow diamonds). For science (green squares), technology (blue dots), and math (orange triangles), the trend is approximately exponential. For engineering, the trend is difficult to identify due to the small number of data points. The math and science data sets begin earlier and follow similar paths, with totals of approximately 130 articles. The rate of increase for the last 10 years is greater in math and science than technology and engineering. Additionally, the rate of increase for technology appears greater for the past 5 years. Articles about engineering anxiety in teachers began to be published in 2014, which is at least 30 years after the first articles about math and science anxiety in teachers were published.

6. Discussion

There are four themes that emerged from the data: (1) the lack of research on engineering and i-STEM, (2) the varied use of the term "anxiety," (3) the representation of technology within the body of research, and (4) the trends in the elements' distribution by year published.

First, there is a lack of material on the anxiety of teaching engineering in comparison to that of teaching other elements, both in the total number and initial publication date of documents. Similarly, investigation into the first question revealed little research on anxiety in i-STEM. One explanation is that engineering has not been present in the K–12 curricula for enough time for researchers to study teachers' anxiety (National Research Council et al., 1999; National Research Council et al., 2008), nor has i-STEM

Another explanation is that teachers are not as anxious about teaching engineering as the other elements. However, the literature indicates that teachers often feel unprepared to teach engineering (Banilower et al., 2013; Hammack & Ivy, 2017; Kang et al., 2018), and that teacher education programs are often not adequate for this subject (National Research Council et al., 2009). It is therefore unlikely that teachers feel confident to teach a subject for which they feel unprepared. These results therefore identify a gap in the research on STEM anxiety.

Second, there are key differences in the use of the term "anxiety." In math, the term "anxiety" is very common. In the other three elements, "self-efficacy" is the more common term, appearing much more frequently than "anxiety." Therefore, the terms are not equally established in research.

Comparing the findings of the ERIC scoping review with the documents in the literature review section, there are nuanced differences. Recall that in the literature review the search terms consisted of an exact phrase, such as "science anxiety," whereas the scoping review did not require an exact phrase and included "self-efficacy" and "teachers." Articles from the review in science and math began to be published in 1980, compared to 1978 in literature (Tobias, 1995). Technology articles began in 1992 in the study and 1985 in literature. Articles on engineering anxiety began to be published in 2014 in the review, but the term “engineering anxiety” found very few relevant results in literature. It could be that anxiety in general terms appeared earlier than anxiety with respect to teachers, which would explain the difference between the scoping and literature review results.

The high representation of the term “anxiety” in math research compared to other elements can be related to the theories and established factors of math anxiety. The existence of these theories indicates that researchers have given much attention to math anxiety; therefore, this study’s finding that “math anxiety” is an established term corresponds to the literature. Essentially, it has more momentum as a research topic.

The difference between the representation of self-efficacy and anxiety across the elements of STEM could be based in the nature of the terms themselves. We can speculate that “self-efficacy” is more commonly used in education because it gives a more positive impression. A teacher completing a survey that uses the term “anxiety” may feel anxious as a result of reading it, while the less-harsh term “self-efficacy” would not elicit the same response. High self-efficacy also represents the opposite of high anxiety, so it may be that this term was adopted to give emphasis on the positive rather than the negative. Also, the term anxiety continues to be used in recent documents, often in conjunction with terms such as attitudes or achievement (Awofala et al., 2019; Fajardo et al., 2019; Novak & Wisdom, 2018; Ozben & Kilicoglu, 2021; Richland et al., 2020). To make the biggest impact on teachers, research should focus on anxiety in order for methods to be developed that help teachers alleviate their anxiety and consequently have a more positive impact on their students.

Third, documents within technology represented 21% of the total body of research collected. There was a more even distribution of papers focusing on primary versus secondary education in technology than in the other elements. However, there were considerably fewer papers in technology that specified an education level; therefore, additional research should be performed to confirm this result. A higher percentage of documents focused on anxiety toward technology integration than technology as an element of STEM. This suggests that research on technology anxiety has given more attention to teachers’ ability to integrate technology across other subjects rather than technology as material for student learning outcomes.

Finally, the trends of the science, technology, and math data sets over time were nearly exponential, while the trend for engineering was not yet possible to determine. There was an increase in the rate of publication of papers within technology in the past 5 years, which indicates that researchers’ interest in technology anxiety is increasing. This finding corresponds with the idea that as everyday tasks are becoming increasingly digitized, technology will receive more attention in future years due to the need for programming professionals. It would be interesting to compare the results in 10 year’s time to see how the trends progress. An interesting note is that although science and math anxiety research has been performed for over 50 years, there is still a lack of STEM professionals. Intervention in K–12 education takes years to be visible in the workplace. Considering the lack of engineering anxiety research, how many years it will take to reach the level of the current science and math research, and how many years it will take for intervention in K–12 education to have an effect on the number of professional engineers in the workforce? There is a pressing need for more research on engineering anxiety to be performed quickly, so methods of reducing engineering anxiety in teachers can broaden and potential engineers can make their way through their education.

6.1. Limitations

To expand upon the results of the study, the search phrases could be adjusted to include additional synonyms for anxiety, the elements of STEM, and teachers. Possible terms could include self-concept, confidence, attitudes, achievement, beliefs, life skills, biology, chemistry, robotics, statistics, primary, secondary, K–12, preservice, and in-service.

Additionally, the searches could be expanded to show results featuring the search terms in the title and abstracts of documents. The tight limit in the searches of the present study ensures accuracy but excludes relevant articles. One example of this is “Exploring Elementary Teachers’ Pedagogical Content Knowledge and Confidence in Implementing the NGSS Science and Engineering Practices” (Kang et al., 2018), which was not a result because the title does not include the terms “anxiety” or “self-efficacy.” Another example is that some articles were excluded from results in science and math because they focused on technology, yet they were not present in the results from technology (Pamuk & Peker, 2009; Worch et al., 2012). The search terms should therefore be expanded to include established frameworks such as TPACK and terms such as “Information and Communication Technologies.” Additionally, the asterisk function should be used to ensure the search will return any terms starting with “tech.”

7. Conclusion

In this study, we reviewed the causes of STEM anxiety in literature, performed and analyzed results from a scoping review with the goal of comparing the representation of the STEM elements in teacher anxiety literature. This study was undertaken to help educators understand potential causes of STEM anxiety in order to reduce attrition in STEM fields, increase students pursuing STEM careers, and contribute to a more knowledgeable population of informed decision-makers who are capable of evaluating technical data.

Section 1 showed that science anxiety is often based in misconceptions about science arising from the distance between science and society. Technology anxiety is varied due to varying definitions and uses of technology. Engineering and i-STEM are recent additions to curricula and teachers’ unpreparedness to affect their anxiety levels. Math anxiety is the most established in research and can arise from the use of authoritarian teaching styles and negative past experiences.

In Section 2, we found that math and science were equally represented, followed by technology, with engineering at the lowest representation. Additionally, engineering documents began to be published at least 30 years after those on science and math. We recommend that a systematic literature review on STEM anxiety be performed with specific attention on engineering anxiety and i-STEM. Researchers should also investigate the differences in the usage of the terms “anxiety” and “self-efficacy” in education and their relation to the elements of STEM and i-STEM. Additional focus should be given to in-service teachers because it was evident that more attention has previously been given to preservice teachers. It is important to investigate the anxiety of those teaching in the classroom because their behavior and confidence levels affect students.

Above all, we recommend that research be performed on teachers’ engineering anxiety. Since engineering has the least representation in the body of research on STEM anxiety, we must work to uncover more information on its prevalence, causes, and ways to reduce it. There is an increasing need for engineers in the world today, and if potential future engineers are negatively affected by their K–12 teachers, this drastically reduces the number of candidates for engineering at the post-secondary level. Teachers' engineering anxiety, therefore, is an issue that must continue to be researched to develop measures to ensure they can feel confident in their teaching and inspire their students to pursue STEM fields.

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Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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Appendix: Search Terms

Search 1: Scopus

- TITLE(science AND (anxiety OR self-efficacy) AND teachers) AND LIMIT-TO (DOCTYPE, "ar"))
- TITLE((technology OR "computer science") AND (anxiety OR self-efficacy) AND teachers) AND LIMIT-TO (DOCTYPE, "ar"))
- TITLE(engineering AND (anxiety OR self-efficacy) AND teachers) AND LIMIT-TO (DOCTYPE, "ar"))
- TITLE(math* AND (anxiety OR self-efficacy) AND teachers) AND LIMIT-TO (DOCTYPE, "ar"))

Search 2: Scopus

- TITLE(science AND anxiety AND teachers) AND LIMIT-TO (DOCTYPE, "ar"))
- TITLE((technology OR "computer science") AND anxiety AND teachers) AND LIMIT-TO (DOCTYPE, "ar"))
- TITLE(engineering AND anxiety AND teachers) AND LIMIT-TO (DOCTYPE, "ar"))
- TITLE(math* AND anxiety AND teachers) AND LIMIT-TO (DOCTYPE, "ar"))

Search 1: ERIC

- TI science AND (anxiety OR self-efficacy) AND teachers, Source Types: Academic Journals
- TI (technology OR "computer science") AND (anxiety OR self-efficacy) AND teachers, Source Types: Academic Journals
- TI engineering AND (anxiety OR self-efficacy) AND teachers, Source Types: Academic Journals
- TI math* AND (anxiety OR self-efficacy) AND teachers, Source Types: Academic Journals

Search 2: ERIC

- TI science AND anxiety AND teachers, Source Types: Academic Journals
- TI (technology OR "computer science") AND anxiety AND teachers, Source Types: Academic Journals
- TI engineering AND anxiety AND teachers, Source Types: Academic Journals
- TI math* AND anxiety AND teachers, Source Types: Academic Journals