



# **The Link between Mathematics Teaching Strategies and Students' Anxiety**

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## **Authors' contributions**

*This work was carried out in collaboration between both authors. Author OMA prepared the original draft, studied conception, designed and reviewed the results of the manuscript. Authors OMA and SBA performed data collection, analysis and interpretation of results. Both authors approved the final version of the manuscript.*

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## **ABSTRACT**

This study focused on the link between Mathematics teaching strategies and students' anxiety in school. This study follows a qualitative approach, using a systematic literature review by evaluating and summarizing the relevant research results on students' Mathematics anxiety and Mathematics teaching strategies. Online databases were searched and ten studies were selected, and only the studies that were published between 2000 and 2022 were included in this study. The studies examined how students' Mathematics anxiety is affected by Mathematics teaching strategies such as the followings: problem-based teaching style, direct teaching style, single instructional approach, systematic and structured approach, creative and discovery approach, inclusive instructional strategies, inquiry-based learning, and student-centered learning methods of teaching. The study concluded that there is a relationship between Mathematics teaching strategies and students' Mathematics anxiety. Student-centered teaching methods, problem-based teaching approaches, creative and discovery approaches, inclusive instructional strategies, and inquiry-based learning were found to reduce Mathematics learning anxiety. Based on the findings, this systematic literature review suggests that a positive and welcoming environment should be created by Mathematics teachers so that concepts in Mathematics can be discussed by students without being afraid of failing, thereby reducing their anxiety in Mathematics.

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## 1. INTRODUCTION

Mathematics is one of the branches of knowledge that focuses on critical thinking, calculation, space, and design which requires abilities in basic reasoning and computations [1]. In addition to physical and scientific studies, Mathematics is utilized to study the humanities, social sciences, languages, and vocational fields [2]. In general, the role played by Mathematics in every aspect of life is essential, but the significant contribution of Mathematics is in the field of education. Mathematics is perceived as one of the subjects that are very difficult to learn as a result of its dynamic, abstract, and complex nature [3,4].

One of the critical success subjects in academic disciplines ranging from Technology, and Science to Economics is Mathematics. Therefore, for high school students to pursue Mathematics at a higher level, excellent qualifications are necessary. In developing countries, the current curriculum needs to be evaluated and reviewed continually to produce a world-class Mathematics education system and improve the quality of education. However, one of the variables that can stop students from benefiting from skills they can acquire from Mathematics in school is students' Mathematics anxiety. Anxiety is a taught behavior that typically appears early in a person's educational journey, and its negative effects will continue throughout the academic years if it is not managed. Students' Mathematics anxiety has persistently hampered students' ability to learn Mathematics [2]. Students who struggle with Mathematics anxiety may also actively avoid quantitative-based tasks.

Students' Mathematics anxiety is a possible hindrance to positive components related to Mathematics. Alam al-Hoda explains Mathematics anxiety as a mental status that individuals attain when managing mathematical content, whether in learning and educating situations or assessing mathematical behavior and solving mathematical problems [5]. Anxiety, as defined by Makari, is the general term for several disorders that cause worrying, apprehension, fear, and nervousness [6]. The fear of failing Mathematics or the fear that Mathematics is too complex often stems from a lack of confidence. Mathematics anxiety

influences how high school students act and feel. Mathematics anxiety is fostered by high school students who have had regular terrible encounters learning Mathematics since they have been made to conclude that they do not have the mental ability to do it.

Mathematics teachers can increase students' anxiety through their choice of teaching methods and teaching too fast or poorly explaining the concepts of Mathematics [7,8]. The social and cognitive aspects of Mathematics teachers, their professional development, interaction, experience, skills, and material knowledge may hinder high school students from having proper Mathematics experience, and this might also lead to long-lasting Mathematics anxiety [9]. For high school students to experience Mathematics learning that will improve their performance in Mathematics and reduce anxiety, the teaching methods of Mathematics teachers should be properly examined.

Teachers have different teaching approaches and styles to ensure that students learn and participate in the subject. However, the teaching methods adopted by a teacher in the Mathematics classroom are influenced by the teacher's social background such as mastery of the subject, personality, educational background, or experiences in the field [2]. In learning Mathematics, the teacher's teaching method is one of the crucial factors in how the students will feel about the subject, retain the knowledge or understand the subject. McKinney et al. noted that some Mathematics teachers use teacher-directed instruction and appear to lecture more frequently than teach Mathematics using student-centered methods [10]. There might be less anxiety if Mathematics teachers engage the students in rich problem-solving mathematical experiences. McKinney et al. also found that the "pedagogy of poverty" is implemented by teachers in high-poverty schools when they teach their Mathematics [10]. They defined "pedagogy of poverty" as a fixed sequence curriculum, a curriculum that did not focus on problem-solving and reasoning but concentrated on just teaching the students basic skills [10]. Considering the damage anxiety in Mathematics learning can cause in high school students, investigating the link between the teaching methods of Mathematics teachers and anxiety among high school students is most important at this time.

## **1.1 The Rationale for the Study**

According to Jackson and Leffingwell, some Mathematics teachers are part of the cause of Mathematics anxiety because students tend to internalize the interest of their teachers and enthusiasm for teaching Mathematics which is shown in the teaching methods adopted by their teachers [11]. Timss established that when it comes to teaching Mathematics in schools, Africa is among the worst [12]. Mounting indicators on the learning of Mathematics and school performance show poor teaching of Mathematics in most of the schools understudied [13]. Lack of confidence in a particular teaching method or teachers' bad attitudes about Mathematics subject can trigger anxiety in high school students. Investigating the link between the teaching methods of Mathematics teachers and anxiety in Mathematics can reduce anxiety in Mathematics among high school students. This study will examine the link between Mathematics teaching strategies and students' Mathematics anxiety in school by reviewing the previous studies.

## **1.2 Objectives of the Study**

The objective of this paper is to acquire data and analyze prior research in the fields of Mathematics anxiety and teaching approaches. The main objective of this paper is to examine the link between mathematical teaching strategies and students' Mathematics anxiety.

## **1.3 Statement of the Study**

Dossel underlined the need for greater research on the reduction of Mathematics anxiety as well as the need for teachers to be more knowledgeable about how it can be reduced and how Mathematics anxiety is engendered [14]. Barnes saw the growing trend of students abandoning Mathematics in their senior year of high school and concluded based on his study of Mathematics anxiety that teachers must create teaching strategies that will reduce anxiety levels in the classroom [15]. Success in Mathematics depends not only on mental processes but also on emotive preparedness. The type of teaching experiences that students are exposed to can also have an impact on how they feel about a lesson or how anxious they are [16]. Kostka and Wilson suggested that future research is required to compare different Mathematics teaching methods to improve math aptitude and reduce

Mathematics anxiety [17]. Therefore, this study will examine the link between mathematical teaching strategies and students' Mathematics anxiety.

## **1.4 Review of Related Literature**

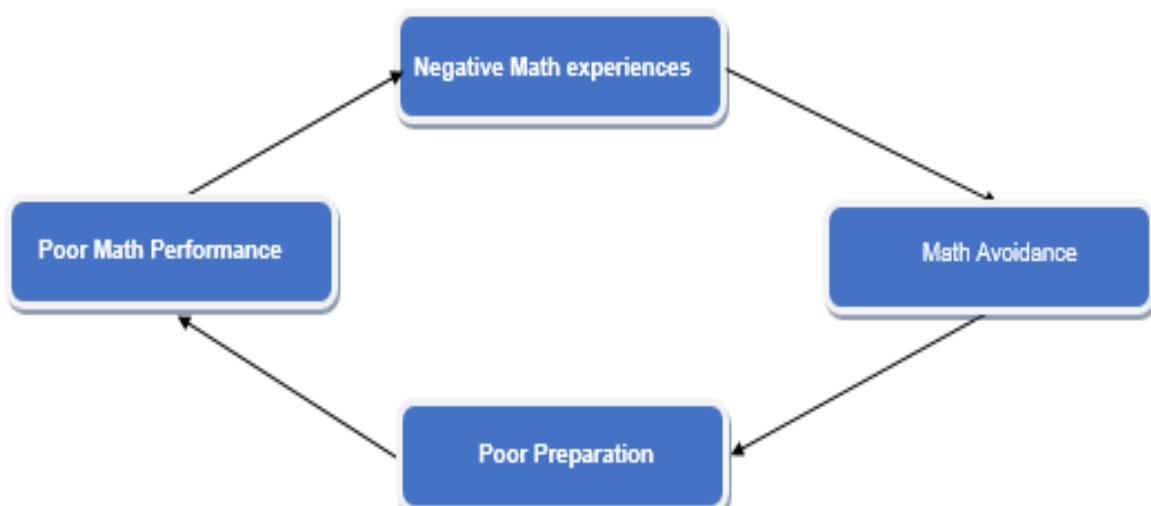
Every country's school curriculum includes Mathematics as a crucial topic [18]. Mathematics has been discussed to help young people comprehend the numerical information that is given to them and to demonstrate make meaning and sense of numerical information (both simple and sophisticated) in day-to-day interactions. Learning Mathematics is cumulative in nature, arranged step-by-step from the easiest problems to the more challenging ones [19]. While students who struggle in Mathematics but believe it is important may not experience Mathematics anxiety, those who struggle but still want to succeed may have higher levels of Mathematics anxiety [20]. Therefore, Mathematics anxiety may contribute to poor mathematical performance [21]. The preconceptions, attitudes, and teaching style of Mathematics teachers are crucial for the development of Mathematics anxiety because they directly impact students' motives, interests, attitudes, and learning activities [22]. Students' developing Mathematics anxiety has been attributed in part to the teacher's teaching methods, which were seen to be crucial. The teaching methods for Mathematics are classified as either "alternative" or "traditional". Newstead [23] explains that the "alternative" teaching approach allows students to discuss their strategies for solving Mathematical word problems, which are used as the primary vehicle for learning. The "traditional" teaching approach discusses the pencil-and-paper, standard methods of computation, by teacher demonstration followed by the individual practice where word sums are given as application after practice and mastering of methods [24]. According to Eden [25], female elementary school teachers who experience Mathematics anxiety also transmit their bad attitudes to their children, which is a contributing cause of Mathematics anxiety [26].

Finlayson [27] identified some of the most effective methods for overcoming Mathematics anxiety. Based on his findings, he encourages Mathematics teachers to use a "constructivist" method of teaching. This method is predicated on the idea that learning happens when students actively contribute to the development of

meaning and knowledge rather than just absorbing information [28]. The method entails engaging in student-centered, participatory activities. Students are urged to collaborate in groups, interact with manipulatives, and use technology as a primary source. Allowing students to build their own unique knowledge based on their earlier experiences and reflect on those experiences is also crucial. In light of this, it's significant to remember that the approach's emphasis is on problem-solving processes and comprehension rather than finding the right solution. Such a method is empowering for learners of all backgrounds. Finlayson mentions several other techniques, such as building self-confidence, relaxation, reaching for help, practicing, taking risks, occupying diverse teaching strategies and an appropriate pace to assessment practices, teaching, and engaging students through math games, videos, technology, and manipulatives [27]. Encouraging students and fostering a supportive environment that allows them to move forward at their speed are the best teaching methods that teachers can use [29]. Mathematics journals, T-charts, surveys, and self-reflections are a few of the additional learning strategies researched by Furner and Duffy [30]. Communicating with students is a crucial strategy that teachers should use to thoroughly grasp their problems and develop practical solutions [30].

### 1.5 The Cycle of Math Avoidance

In the first phase, as stated in this model, adverse reactions to Mathematics situations are experienced by the students [31]. These might result from past negative experiences of the students with Mathematics teaching, which leads to the second phase of this model where the students avoid anything that involves Mathematics. And avoiding Mathematics situations can lead to poor Mathematics preparation, which is the third phase of this model. This poor preparation leads to phase four, which is poor Mathematics performance. More negative experiences with Mathematics learning are then generated and these go back to phase one of this model. The repetitions of this cycle can make anxious persons conclude that they cannot learn Mathematics, and the Cycle is rarely broken [32]. Some studies concluded that there is a deficient inhibition mechanism for Mathematics-anxious individuals whereby task-irrelevant distracters consume working memory resources [33]. Preis and Biggs noted that students that perform poorly in examinations and tests affirm that they become confused, keep thinking about their poor performance in Mathematics, or are unable to concentrate on the task at hand [34]. Mathematics anxiety degrades the accuracy of working memory and slows down performance because the ongoing task-relevant activities of working memory are disrupted [35].



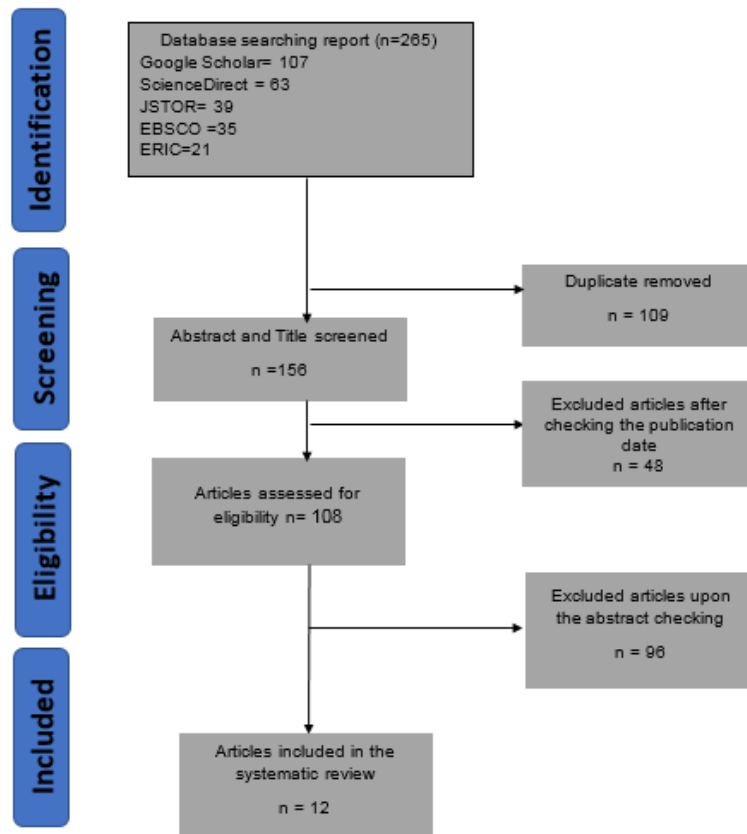
**Fig. 1. Cycle of math avoidance model**  
*Adopted: price and biggs(2001)*

## 2. METHODOLOGY

The systematic literature review will be used to examine the link between Mathematics teaching strategies and students' anxiety to have a comprehensive and clear overview of the evidence available. The systematic literature review aims to summarize and evaluate the identified findings of relevant individual studies [36] on Mathematics teaching strategies and students' anxiety. This will make the evidence available more clear and understandable to decision-makers. Published literature on Mathematics teaching strategies and their influence on students' anxiety was searched. The studies that were searched were published between 2000 and 2022. Students in secondary schools and students in higher institutions of learning were study respondents in the studies that were included. Studies that included information on the teaching strategies of Mathematics teachers in secondary and tertiary institutions were also included. Google Scholar, ScienceDirect, JSTOR, ERIC, and EBSCO were the databases used for the data collection. The

search keywords used to find articles were: Mathematics anxiety, Mathematics teaching strategies, Students' Mathematics anxiety, teaching methods, Mathematics belief, the effect of Students' Mathematics anxiety, fear of Mathematics, and Mathematics teachers' styles.

The publications that did not address the study question and inclusion criteria were discarded after two reviewers independently read through the articles. Both reviewers then screened the final list. The literature that did not fit the requirements was eliminated after discussion and agreement. For instance, studies that only discussed predisposing factors, such as a student's financial background or the number of children in the family of the student, or the gender of the student, without providing data on how the methods adopted by the teachers influence the student's anxiety; including studies that were based on students' Mathematics anxiety and how it affects student's academic performance but did not address how Mathematics teaching strategies affects the students' anxiety were discarded.



**Fig. 2. Systematic search strategy in accordance with PRISMA [37]**

*Source: Author's compilation*

## **2.1 Data Collection**

The complete search from all researchers turned up 265 pieces of literature, of which 236 were found appropriate using the five databases, and 29 were found by manually examining journal reference lists inappropriate. After removing the duplicates when materials from both researchers were combined, the abstracts of the materials were scrutinized, 154 full-text articles were evaluated for eligibility and 48 were excluded after checking the publication date. Out of these 106 studies were considered to be suitable. This paper finally used 12 journals as a result of the agreement between the first researcher and the second researcher. The literature included articles that demonstrated the relationship between Mathematics teaching strategies and students' anxiety in school. Fig. 2 summarizes the article selection process.

## **3. RESULTS AND DISCUSSION**

33% of the papers included in this research, suggested problem-based as a crucial teaching style in reducing Mathematics anxiety. Sandt and O'Brien focused on two teaching styles, a problem-based teaching style and a direct teaching style [38]. The study revealed that a problem-based teaching approach may reduce students' Mathematics anxiety and thereby boost mathematical skills. The study indicated that problem-based teaching styles contribute to the reduction of students' anxiety about Mathematics. Insight into the ability of problem-based teaching style to reduce students' Mathematics anxiety was given by Walker and Leary [39]. Although Hodara's findings showed that a single instructional approach is rarely beneficial for all students, the study found that a problem-based teaching approach significantly reduced students' Mathematics anxiety in a course on Mathematics subjects that was contextualized for use in education [40]. Burghardt et al. [41] noted that to reduce students' Mathematics anxiety, Mathematics teachers need to integrate problem-based teaching methods in preparing for their classes.

According to the literature (8.3%), the creative and discovery approach may reduce Mathematics anxiety in students. Thijsse categorizes teaching methods into two which are the systematic and structured approach, and the creative and discovery approach [42]. The study revealed how the teaching approach adopted by Mathematics teachers can reduce students'

Mathematics anxiety. The study used the Kumon method as the intervention program, which was developed based on the principles of the late Japanese educator and founder of the Kumon Educational Institute, Toru Kumon. The study observed the changes in the anxiety levels of students using the Kumon program. The study found that students in the Kumon program had favorable experiences with the creative and discovery approach. The study discovered that starting at simple levels and practicing the material repeatedly improved their ability and confidence in Mathematics because it reduces their anxiety. The student who displayed an increase in anxiety demonstrated a decline in performance on the Kumon post-test in classrooms where a systematic and structured approach was used to teach Mathematics. It was discovered that students' Mathematics anxiety is influenced by the teaching method adopted by Mathematics teachers.

Two papers (16.67%) argue that instructional strategies are needed to reduce Mathematics anxiety in students. Gresham and Burleigh reported that an inclusive instructional strategy promotes children's confidence in Mathematics and reduces their anxiety [43]. The study noted that many Mathematics teachers choose a curriculum and/or teaching approach that is solely centered on the teacher without any consideration for students that are anxious about Mathematics. In the study of Lorenzen, the influence of instructional strategies was examined on students' Mathematics anxiety [44]. A paper (8.3%) considers the inquiry-based learning approach as effective in reducing anxiety in students. Lorenzen revealed that the inquiry-based learning participants exhibited decreased levels of anxiety after the semester. Individuals in inquiry-based learning showed less self-reported anxiety than participants in traditional learning [44].

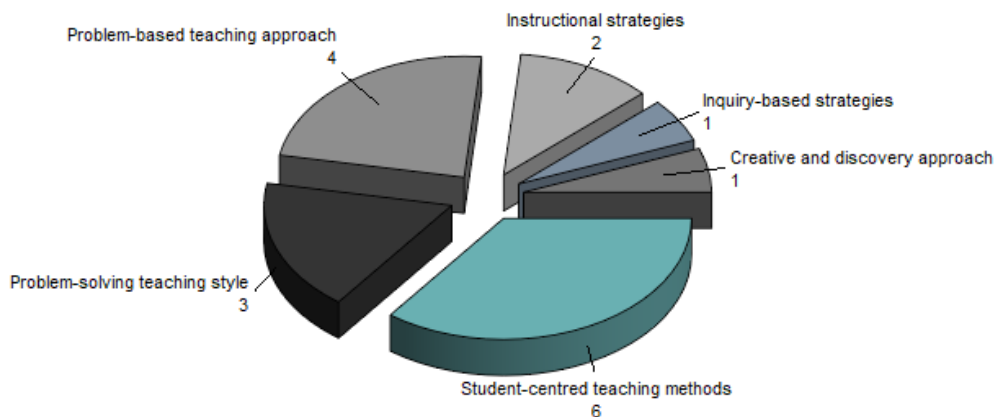
50% (n=6) of the papers state explicitly that students' Mathematics anxiety may reduce when student-centered teaching methods are adopted by Mathematics teachers. Lorenzen affirmed that student-centered learning methods of teaching and traditional methods of teaching are the two instructional styles that teachers frequently employ in Mathematics courses [44]. The study concluded that individuals under the inquiry-based method have more chance of reducing students' Mathematics anxiety. However, these findings contrast with those of Alsup, who discovered that students enrolled in Mathematics

classes where traditional methods were used showed a greater decline in students' Mathematics anxiety than those enrolled in constructivist, active-learning classes [45]. Emanate showed that student-centered teaching strategies can help students who are anxious about Mathematics [46]. Altun stated that the type of teaching method adopted by Mathematics teachers can have an impact on how the students feel about Mathematics or how anxious they are [47]. This is consistent with the findings of Bekdemir who concluded that students' Mathematics anxiety in pre-service elementary teachers is influenced by the poorest and most challenging Mathematics classroom experiences because the teachers did not use a student-centered teaching approach [48]. The results demonstrate that many pre-service teachers struggle with anxiety because of the type of teaching methods adopted by the teachers. Kulkin concluded that most students believed that Mathematics is difficult because their teachers do not use a student-centered curriculum [49]. The students enrolled in classrooms where a student-centered curriculum was used by the teachers demonstrated that their anxiety was reduced. The study added that a student-centered curriculum helps students attain mastery through problem-solving.

3 (25%) of the 12 papers reviewed in this study argued that adopting a problem-based teaching style is not enough to reduce Mathematics anxiety, the papers stated that a problem-solving teaching style will reduce anxiety in students. Gholami [50] used Mathematics Anxiety Scale-Revised to measure students' Mathematics

anxiety with 86 students grouped into an experimental group and a control group. The study found that there is a detrimental correlation between students' Mathematics anxiety and teaching methods [50]. Students in the experimental group used a student-centered approach to tackle problems both individually and in groups. Students in the control group received instruction using the standard approach. The children's aptitude for problem-solving was evaluated using a Mathematics test. The outcomes demonstrated a substantial difference in students' Mathematics anxiety and accomplishment scores between the experimental and control groups. Student-centered teaching methods were discovered to be an effective technique for boosting the students' capacity for problem-solving and lowering their anxiety.

Alkan noted that effective teachers need to consider new strategies for teaching Mathematics to improve students' attitudes toward Mathematics [51]. Also, a positive and welcoming environment should be created by teachers so that concepts in Mathematics can be discussed by students without being afraid of failing, thereby reducing their anxiety in Mathematics. To reduce Mathematics anxiety in students, Mathematics teachers should choose teaching strategies such as using games to impact mathematical knowledge, reviewing the given topic through exercises and examples, making Mathematics relevant, getting support from parents, and motivating pupils. Students should be allowed to form their understanding based on the experiences they have before and reflecting on those experiences is important.



**Fig. 3. Distribution of Mathematics teaching strategies**



With this in mind, rather than just working towards getting the correct answer, the approach should focus on the process of understanding and problem-solving, which is more important. This type of strategy is validated for diverse learners as discovered in this study. As shown by this study, the effective teaching strategy is when teachers provide encouragement to the students and a nurturing environment is created where students are allowed to proceed at their own pace.

#### **4. CONCLUSION**

Twelve papers that were systematically reviewed in this study revealed the link between Mathematics teaching strategies and students' anxiety. Mathematics teaching strategies such as the followings: problem-based teaching style, direct teaching style, single instructional approach, systematic and structured approach, creative and discovery approach, inclusive instructional strategies, inquiry-based learning, and student-centered learning methods of teaching were examined in relation to students' anxiety. Given the well-documented evidence emphasizing the benefits of student-centered teaching to students, this study inferred that teacher-centered learning on its own cannot effectively address the issues of students' Mathematics anxiety. This study shows that teachers that embrace a wholly student-centered approach to curriculum and instruction produce results that are centered on meeting the needs of the students. The problem-based teaching approach was also found to reduce students' Mathematics anxiety and boost mathematical skills. The literature reviewed also revealed that an inclusive instructional strategy promotes students' confidence in Mathematics and reduces their anxiety. However, Mathematics teachers need to adopt balanced teaching strategies to be more inclusive and reduce anxiety in students. To reduce students' Mathematics anxiety, Mathematics teachers need to integrate problem-based teaching methodologies, student-centered teaching methods, problem-based teaching styles, creative and discovery approaches, instructional strategies, and inquiry-based learning approaches in preparing for their classes. The extremely abstract nature of mathematical symbols undoubtedly adds to the challenges that people have when learning Mathematics, this contributes to Mathematics teachers' burnout and Mathematics anxiety among students.

#### **4.1 Delimitation of the Study**

Mathematics anxiety in students: Although Mathematics anxiety can occur among teachers, this study's focus is on Mathematics anxiety in students across all categories of schools. This study ignored anxiety in other subjects but focus on Mathematics anxiety alone.

Literature study: The nature and related impacts of Mathematics anxiety, and teaching methodologies and strategies in this study were all the subject of a literature review. The nature of the connection between Mathematics anxiety and the Mathematics teaching approach is examined in this study making inferences from previous studies.

#### **COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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