The systematic literature review of the link between mathematical teaching strategies and students' mathematics anxiety.

ABSTRACT

This study focused on the link between mathematical teaching strategies and students' mathematics 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 mathematical teaching strategies. Online databases were searched and ten studies were selected, only the studies that were published between 2000 and 2022 were included in this study, the studies reviewed examined how students' mathematics anxiety is affected by mathematical teaching strategies such as problem-based teaching style, direct teaching style, single instructional approach, systematic and structured approach, creative and discovery approach, inclusive instructional strategy, instructional strategies, inquiry-based learning, and student-centred learning methods of teaching. The study concluded that there is a relationship between mathematical teaching strategies and students' mathematics anxiety. Student-centred education, problem-based teaching approach, creative and discovery approach, inclusive instructional strategy, instructional strategies, and inquiry-based learning were found to reduce mathematics 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 math can be discussed by students without being afraid of failing, thereby reducing their anxiety in mathematics.

Keywords: Mathematics anxiety, Student-centred approach, problem-based approach, creative and discovery approach, inclusive instructional strategy, instructional strategies, inquiry-based learning

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 the physical and scientific sciences, 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 elements in 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 mathematics anxiety. Anxiety is a taught behaviour that typically appears early in a person's educational journey, and if it takes root, its negative effects will continue throughout the academic years if it is not managed. Mathematics anxiety has persistently hampered students' ability to learn mathematics [2]. Students who struggle with mathematics anxiety may also actively avoid quantitative-based tasks. Mathematics anxiety is a possible hindrance to positive components related to mathematics. Alam al-Hoda [5] explains mathematics anxiety as a mental status that individuals attain when managing mathematical content, whether in learning and educating situations or assessing mathematical behaviour and solving mathematical problems. Anxiety, as defined by Makari [6], is the general term for several disorders that cause worrying, apprehension, fear, and nervousness. The fear of failing mathematics or the fear that mathematics is too complex or not solving mathematical problems 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, through social and cognitive aspects like their teaching quality as teaching too fast or poorly explaining, professional development, interaction, experience, skills, and material knowledge [7, 8] may hinder high school students from having proper math experience, and this might also lead to long-lasting mathematics anxiety [9]. For high school students to experience math that will improve their performance in mathematics and reduce mathematics 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, mastery of the

subject, personality, educational background, or experiences in the field. 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. [10] noted that some math teachers use teacher-directed instruction and appear to lecture more frequently than teach math using student-centred methods. There might be less anxiety if math teachers engage the students in rich problem-solving mathematical experiences. McKinney et al. [10] also found that the “pedagogy of poverty” is implemented by teachers in high-poverty schools when they teach their mathematics. 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. Considering the damage anxiety in mathematics can cause in high school students, investigating the link between the teaching methods of mathematics teachers and anxiety in mathematics among high school students is most important at this time.

According to Jackson and Leffingwell [11], 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 math which is shown in the teaching methods adopted by their teachers. Timss [12] established that when it comes to teaching mathematics in schools, Africa is among the worst. 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 can trigger anxiety in high school students. Investigating the link between the teaching methods of mathematics teachers and anxiety in mathematics can reduce mathematics among high school students. There have been many studies on the effect of mathematics anxiety on the performance of students in mathematics, and many scholars have studied the causes of mathematics anxiety but not much has been done on how teaching methods of mathematics teachers affect anxiety in mathematics in schools, this study will examine the link between mathematical teaching strategies and students' mathematics anxiety in school by studying the precious studies.

The Cycle of Math Avoidance

In the first phase, as stated in this model, adverse reactions to math situations are experienced by the student [15]. These might result from past negative experiences of the student with mathematics, which leads to the second phase of this model where the student avoids anything that involves mathematics. And avoiding math situations can lead to poor mathematics preparation, which is the third phase of this model. This poor preparation leads to phase four, poor math performance. More negative experiences with mathematics are then generated and go back to phase one of this model. The repetitions of this cycle can make the anxious person conclude that they cannot do mathematics, and the Cycle is rarely broken [16]. The biological studies concluded that there is a deficient inhibition mechanism for mathematics-anxious individuals whereby task-irrelevant distracters consume working memory resources [17]. Preis and Biggs [18] noted that students that perform poorly in examinations and tests affirm that they become confused, keep thinking about how their poor performance in mathematics, or are unable to concentrate on the task at hand. Mathematics anxiety degrades the accuracy of working memory and slows down performance because the ongoing, task-relevant activities of working memory are disrupted.

2. METHODOLOGY

The systematic literature review will be used to examine the link between mathematical teaching strategies and students' mathematics 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 [19] on mathematical teaching

strategies and students' mathematics anxiety, this will make the evidence available more clear and understandable to decision-makers. Published literature on mathematical teaching strategies on students' mathematics 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 participants in the studies that were included. Studies that included information on 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: Mathe anxiety, mathematical teaching strategies, and mathematics anxiety, teaching methods, mathematical belief, the effect of 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 addressing those criteria. Both of the reviewers 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 students, without providing data on how the methods adopted by the teachers influence the student's anxiety; studies that were based on mathematics anxiety and how it affects students academic performance but did not address how mathematical teaching strategies affects the students' mathematics anxiety.

Data Collection

The complete search from both researchers turned up 265 pieces of literature, of which 236 were found using the five databases and 29 were found by manually examining journal reference lists. After duplicates were eliminated and abstracts were scrutinized, 154 full-text articles were evaluated for eligibility and 48 were excluded after checking the publication date. Out of these 106 studies that were considered to be suitable, 10 papers were included in the final review as a consequence of the agreement between the first researcher and second reviewers over the omitted publications. The literature included articles that demonstrated the relationship between mathematical teaching strategies and students' mathematics anxiety in school. Figure 1 summarizes the article selection process.

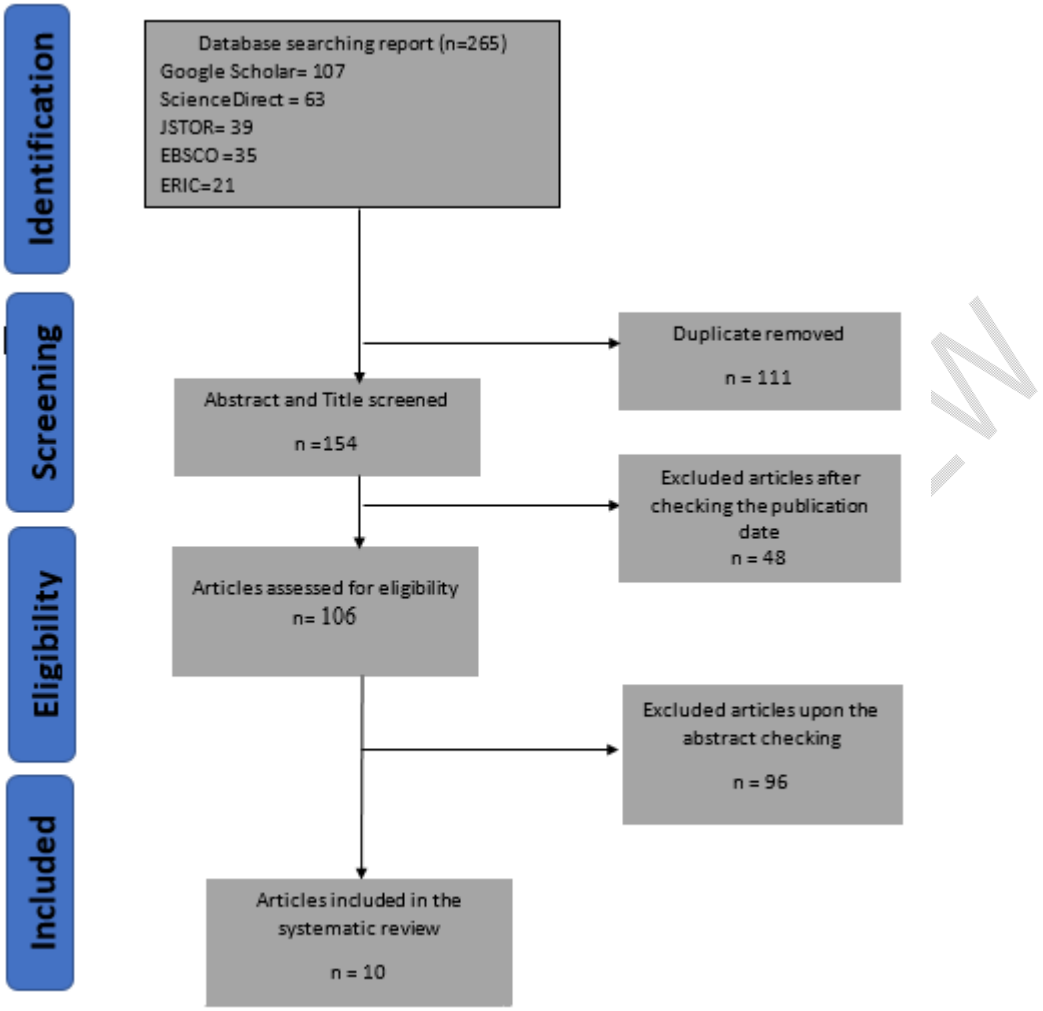

Figure 1: Systematic Search Strategy in Accordance with PRISMA [20].
Source: Author's compilation

3. RESULTS AND DISCUSSION

Sandt and O'Brien [21] focused on two teaching styles, a problem-based teaching style and a direct teaching style. The study revealed that a problem-based teaching approach may reduce mathematics anxiety and thereby boost mathematical skills. The study concluded that problem-based teaching styles contribute to the reduction of mathematics anxiety in students. Insight into the ability of problem-based education teaching style to reduce mathematics anxiety was given by Walker and Leary [22]. Although Hodara's [23] findings showed that a single instructional approach is rarely beneficial for all students, the study found that a problem-based teaching approach significantly reduced mathematics anxiety in a course on math subjects that was contextualized for use in education. Burghardt, et al. [24] noted that to reduce students' mathematics anxiety, mathematics teachers need to integrate problem-based teaching methodologies in preparing for their classes.

Thijsse [25] categorize teaching methods into two which are systematic and structured approach, and creative and discovery approach. The study revealed how the teaching approach adopted by mathematics teachers can reduce 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 anxiety levels of students using the Kumon program. The study found that students in the Kumon program had favourable experiences with the creative and discovery approach. The study discovered that starting at simple levels and practising the material repeatedly improved their ability and confidence in mathematics because it reduces their mathematics anxiety. The student who displayed an increase in mathematics 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 mathematics anxiety is influenced by the teaching method adopted by mathematics teachers. Gresham and Burleigh [26] reported that an inclusive instructional strategy promotes children's confidence in mathematics and reduces their mathematics anxiety. The study noted that many math teachers choose a curriculum and/or teaching approach that is solely centred on the teacher without any consideration for students that are anxious about mathematics.

In the study of Lorenzen [27], the influence of instructional strategies was examined on mathematics anxiety. The study affirmed that student-centred learning methods of teaching and traditional methods of teaching are the two instructional styles that teachers frequently employ in mathematics courses. The study revealed that the inquiry-based learning participants exhibited decreased levels of anxiety after the semester. Individuals in inquiry-based learning showed less self-reported mathematics anxiety than participants in traditional learning. The study concluded that individuals in inquiry-based have more effect on reducing mathematics anxiety. However, these findings contrast with those of Alsup [28], who discovered that students enrolled in mathematics classes where traditional methods were used showed a greater decline in mathematics anxiety than those enrolled in constructivist, active-learning classes.

Emanet [29] showed that student-centred teaching strategies can help students who are anxious about mathematics. Altun, [30] 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. This is consistent with the findings of Bekdemir [31] who concluded that 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-centred teaching approach. The results demonstrate that many pre-service teachers struggle with mathematics anxiety because of the type of teaching methods adopted by the teachers. Kulkin [32] concluded that most study students believed that math is difficult because their teachers do not use the student-centred curriculum. The students enrolled in classrooms where a student-centred curriculum was used by the teachers demonstrated that their mathematics anxiety was reduced. The study added that a student-centred curriculum helps students attain mastery through problem-solving. Gholami, et al., [33] used Mathematics Anxiety Scale-Revised to measure mathematics anxiety with 86 students and were grouped into an experimental group and control group, the study found that there is a detrimental correlation between mathematics anxiety and teaching methods. Students in the experimental group used a student-centred 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 math test. The outcomes demonstrated a substantial difference in mathematics anxiety and accomplishment scores between the experimental and control groups' means. Student-centred teaching methods were discovered to be an effective technique for boosting the students' capacity for problem-solving and lowering their anxiety.

4. CONCLUSION

Given the well-documented evidence emphasizing the benefits of student-centred education to students, it is easy to understand that teacher-centred learning on its own cannot effectively address the issues of mathematics anxiety. This study shows that teachers that embrace a wholly student-centred approach to curriculum and instruction produce results that are centred on meeting the needs of the students. The problem-based teaching approach was also found to reduce mathematics anxiety and boost mathematical skills. The literature reviewed also revealed that an inclusive instructional strategy promotes children's confidence in mathematics and reduces their mathematics 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 in preparing for their classes.

Alkan [34] noted that effective teachers need to consider new strategies for teaching mathematics to improve students' attitudes to mathematics. Also, a positive and welcoming environment should be created by teachers so that concepts in math 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 by exercises and examples, making math 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. 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.

COMPETING INTERESTS

No competing interests. We did not receive any financial support from anybody or organization.

CONSENT

This is a systematic literature review; the research is well referenced.

ETHICAL APPROVAL

No confidential, sensitive or deeply personal information was collected from participants.

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