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Systematic Literature Review on Secondary School Students Mathematics Anxiety

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Abstract

Mathematics is considered as a tough subject in education. Mathematics anxiety is a feeling associated with stress, anxiety when it comes to manipulating numbers and solving, problem-solving questions. These mathematics anxiety can cause one to feel powerless and unable to solve any problems involving mathematical calculation. It also causes a person to feel fear and phobias with anything related to the subject. The purpose of this research was to perform a systematic analysis study based on studies concerning 'Secondary School Students Mathematics Anxiety'. 27 articles were analysed to answer the questions in this systematic literature review. ERIC and Research Gate database were used in this study. This study was conducted to analysis the achievement and the factors that contributed to the anxiety. Most of the studies were carried out on secondary school students. This was also noted that the majority of studies examined were formulated according to quantitative approaches. From this study one can conclude that the qualitative studies and the mix method conclusion were lacking, this systematic review study is important for everyone, especially teachers, parents and students alike recognizing the existence of mathematical concerns in schooling and beyond devised intervention measures to help students in secondary schools.

Keywords: Mathematics Anxiety, Secondary School Students, Achievement, Factors.

Introduction

In this era of globalization, our lives are closely related to mathematics. From buying basic necessities at a grocery store, looking at the clock in order to determine everything involves computing math. The competitive economy of the world has necessitated continuous reform in mathematics education. The success of an educational organization is based on student achievement in the academic field. Mathematics lessons are constantly changing in terms of contents, usage and method learn from it and contribute to the achievement of national aspirations. Pupils consider mathematic subject is a difficult subject to master. There are students who have shown good results and there are those who continue to fall behind in mastering these subjects.

Mathematics is a unique subject and is fundamental to the school curriculum. This is an instrument for other subject development. Consciously or not, we use math in every aspect of life. However, the majority of students worldwide do not like math (Gafoor, 2015; Darwish,

& Abdeldayem, 2019). This subject is often considered difficult subject that are impossible to master (Phang, Abu, Ali, & Salleh, 2014; Chowdhury, 2014). Students achievement in mathematics subjects must be taken seriously. Low student achievement can effect student learning if not handled earlier, which can lead to problems that arise at a higher level. Learning math is often considered a difficult and tedious task for some students. As a result, students are not confident in solving math problems in academic or everyday life (Veloo, Ali, & Krishnasamy, 2014).

Various factors have been studied by experts in the field of research to find the decline causes and problems in mathematics learning such as early achievements, basic skills, interests, attitudes, motivation and problem-solving skills are some of the factors that caused this problem. These factors are among the factors that can cause the phenomenon to occur in achievement in Mathematic subject in schools.

According to Lazzarus (1974), a student can have intellectual and emotional barriers when studying mathematics all their life in school. This creates a barrier for students to show their true potential or to do their best in solving problems. There are a number of reasons for this concern. One of the reasons is that adults channeled, conveyed or expressed their concern about the subject and subsequently influenced children. Teachers who have mathematics concerns can pass on to their students (Kelly & Tomhave, 1985; Bulman & Young, 1982; Laarus, 1974).

Mathematics anxiety is a real problem that can impact on an individual achievement of goals, career choices and life as a whole. Major emphasis is the question of student academic achievement, which is widely spoken by parents, teachers and the community. Mathematical anxiety has a profound impact on the person who encounters it. Tapia (2004) found students with mathematics difficulties had a higher learning drive than those with high issues in mathematics.

According to Richardson & Suinn (1972), mathematics anxiety is associated with feelings of stress and fear related to number manipulation as well as mathematical problem solving in a variety of ways academic situations and everyday life. This causes the brain to limit its ability to work and affect his ability to solve math problems.

Tobias (1998) defines mathematical anxiety as a feeling of insecurity because can not answer mathematical questions. Whereas Bandalos et al. (1995) defined mathematical anxiety as a combination of weakening test pressure, low self-esteem, fear of failure and being negative about math learning

Anxiety is divided into two types: state anxiety and trait anxiety. Anxiety is a subjective characteristic, which includes anxiety and conscious awareness followed by the anxiety raised by the nervous system (Spielberger 1985). State or state anxiety is temporary and fluctuates over time as individuals receive potentially harmful stimuli and imaginations about the existence of stimuli. Next, the individual will react in different degrees depending on the level of threat he or she feels. Trait or trait anxiety refers to personality differences that are relatively stable when one perceives a situation that is not directly threatening. It is also an individual personality disorder when stimulated by threats (Endler and Kocovski, 2001).

Mathematical anxiety is described as involving feelings of tension and anxiety which interfere in a variety of everyday and academic situations with the manipulation of numbers and solutions to mathematical problems (Richardson & Suinn, 1972). Among leading researchers in the field of mathematics, Richardson and Suinn (1972), from a more

general perspective, described mathematical anxiety as "*The feeling of tension that impedes the use of numbers and completes mathematical operations in everyday life*". Fennema and Sherman (1978) refer to mathematical anxiety as fear, anxiety and body related symptoms associated with doing mathematics.

Yakubu (2018) stated that mathematics anxiety is usually linked to prior negative mathematics experience. These could include being punished by present or past teachers for failing to solve mathematics concepts, having a bad grade on math in school, lack of encouragement from parents or teacher, and/or lack of positive role models. The people who often have this problem are the students, no matter the students, matriculation or university and math teacher. Mathematics teachers sometimes also have this problem while in the classroom especially when students ask questions.

Ashcraft (2002) suggests that anxiety among students will make them avoid situations where they need to do math calculations. Unfortunately, mathematical avoidance affects students' lives and is directed to less proficiency, less exposure to math, more anxious students and not ready to face math.

The relationship of students with mathematics anxiety can be seen in a variety of factors. Student those with mathematical worries will try to avoid the series numbers and any mathematical problems. The impact of mathematical anxiety on the personality of teachers has a great impact to the students. In addition, the attitude and views of a student who has always regarded mathematics as difficult subjects will affect mathematics anxiety. Effects in terms of negative thinking like this will cause students to lose interest in learning more math.

Background

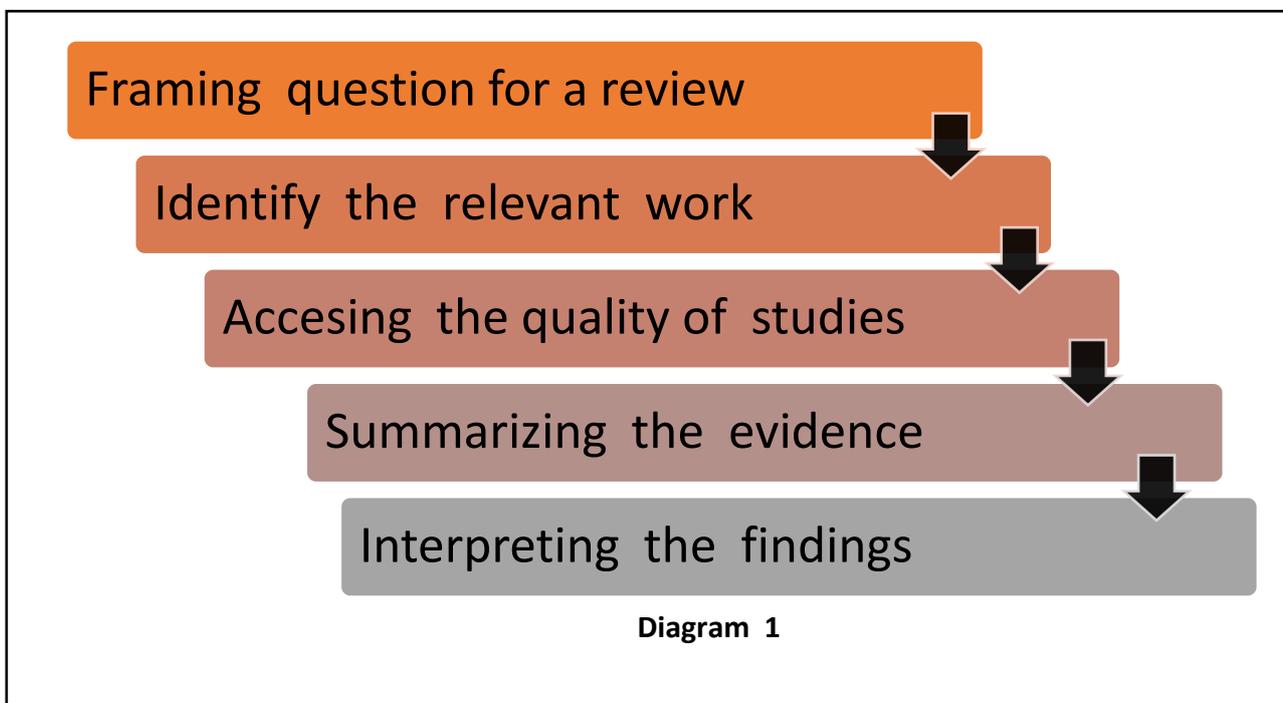
McLeod (1992) refers to anxiety, trust, frustration and discontent as attitude. Mathematical anxiety is also often referred to as distress that a person may experience when asked to do something related to mathematical activities (Wood, 1999) or feeling of stress, disabilities and mind unplanned to manipulate numbers and forms (Richardson & Suinn, 1972; Tobias, 1985).

The study of mathematics anxiety as a separate construct began in 1950, however, most of the empirical studies were conducted before 1970 were related to the whole attitude towards mathematics, and did not stand out for the anxiety of learning. In the early 1950s, mathematics anxiety was introduced as metamaphobia by Mary Fides Gough. It is a feeling to describe the feeling of dislike or phobia towards mathematics. Mathematics anxiety scale was first introduced by Richardson dan Suinn in the year 1972. Over the last decade the recognition and knowledge towards mathematics anxiety has grown considerably, but the need to discover more is needed.

Since we know that mathematics is inseparable from our life so its important to master the subject. People with mathematics anxiety faces challenges with their life due to lack of confidence in mathematics. Researches are working to learn more about mathematics anxiety. Researches are still making headway in this area. Mathematics anxiety research has shown that it occurs in early childhood and is linked to social conditions as well as brain functions such as working memory.

Method

A systematic review is a research method consisting of the selection of previous studies relating to a specific topic, critical assessment. Those studies were analyzed based on all the relevant systematic rule (Millar 2004; Corcoran & Pillai 2008; Torgerson 2003). When carrying out a systematic literature review, all the information collected using online database according to Fink (2014). To find articles that meet the criteria in this study, researcher have selected two database namely ERIC (Education Resource Information Centre) and ResearchGate. Article search has been conducted between 2016 till 2020 using several keyword combinations like mathematics anxiety, secondary students, achievements and factors. In this analysis, the purpose and the questions emerging were decisive. The selection process does not include theses, books, projects and conference papers. For this study, five measures from Khan et al. (2003) were used to carry out the analysis process. The five steps are given below in Diagram 1



Step 1 : Framing questions for a review

This study aimed to investigate the previous studies related to `anxiety in mathematics` considering their factors and achievement among mathematic anxiety students. Therefore, to study previous studies focused on mathematics anxiety a systematic research approach was used. The articles chosen for this review were the papers that established the secondary school students relationship with mathematics anxiety.

Stage 2 : Identifying Relevant Work

Researchers also handle search strategies on all the referral lists included in the article. Preliminary checks have been carried out based on the articles and abstracts. Full text is searched for articles that meet the

eligibility criteria based on the title and abstract and then the final selection of studies is determined by the criteria included and excluded.

Systematic and clear methods were used to classify, pick and critically review applicable research reports from major educational sources, after formulating the research query. To capture as many relevant articles as possible, a wide range of databases were searched to identify primary studies of the secondary school students' mathematics anxiety. Firstly, online databases which is ERIC (Education Resources Information Centre) and ResearchGate were used to conduct the search.

Secondly their potential relevance were examined and 50 articles were excluded as irrelevant based on inclusion and exclusion criteria in this review. It should be noted that even books, theses, project and conference papers are not included in the process of scanning and review. Those articles with abstracts were omitted after the completion of downloading papers published in the journals. On top of that, although many papers were listed after the research, some of them were not related to the main topic. Those not using 'mathematics anxiety' in the keyword section and not directly related to the main subject were also excluded.

English language peer-reviewed journal articles and full-text articles were the limiter in this review. Keywords such as "mathematics anxiety among secondary school students" and "mathematics anxiety" AND "factors" and "mathematics anxiety" AND "achievement " were also used while searching for the relevant articles.

Esearchers also handle search

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Stage 3: Accessing the Quality of Studies

According to Millar (2004) a researcher will pursue these steps, using systematic review analysis. The steps are i) Framing questions for a review, ii) Identifying relevant work iii) Accessing the quality of studies. Within this analysis, attention is paid to all these stages and the process is carried out on the basis of research. Throughout this analysis, the main purpose and the questions extracted were decisive. In this context, this study designed in terms of the method of systematic review as the given criteria: The articles, published between 2016 and 2020, based primarily on mathematics-related anxiety in educational setting-published in journals and available in full-text/peer-linked and the participants were limited to secondary school students which includes middle and high school students.

The articles, published between 2016 and 2020, based primarily on mathematics-related anxiety in educational settings-published in journals and available in full-text/peer-linked and the participants were limited to secondary school students which includes middle and high school students.

The articles being directly related to anxiety in mathematics was the important criteria in the selection of papers for this study. In other words, articles based on subjects such as 'anxiety in teaching mathematics', 'mathematics test anxiety' and specifically 'mathematics attitudes' were removed.

Stage 4: Summarizing the Evidence

The goal of this research was to examine the previous studies linked to 'mathematics anxiety' considering the relationship between mathematics anxiety of students and their performance and the factors that could affect their mathematics achievement. As regards the systematic review rules and based on study questions, 117 studies conducted between 2016 and 2020 have been downloaded from ERIC and ResearchGate database. There were 34 articles from ResearchGate that were attained from the online journals within the same range of years. The total number of articles screened was 151. The articles were screened for the inclusion criteria which was full text articles and peer-reviewed in English. 50 duplicated articles were removed from this survey. Other exclusion criteria were primary school, college, matured students, university and those without full articles. Only 27 articles were taken into consideration in this review after a long process of summarization. The process is shown in the Prisma Flow diagram 2

PRISMA Flow Diagram

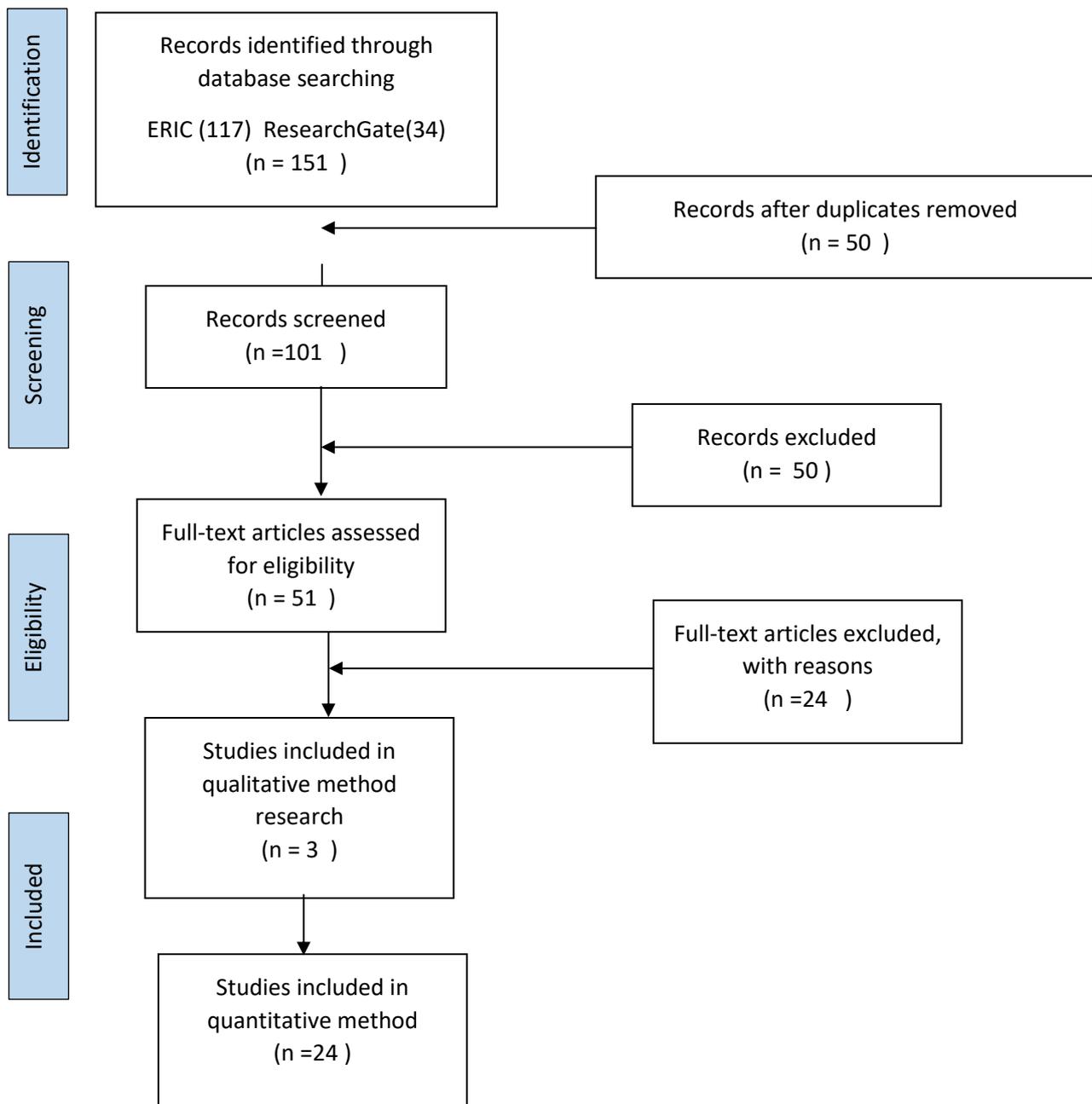


Diagram 2 prisma Flow chart

Stage 5: Interpreting the Findings

The research analysed in this analysis found that most of these research were using quantitative methods. These quantitative studies were planned as outlined in Table 1 below, using survey method. Besides this very few studies using qualitative and mixed method approaches compared to quantitative method. 27 articles in this review was split into two categories. There were 24 quantitative studies and 3 qualitative his study was based on the research questions. Firstly the relationship of secondary school students` mathematics anxiety and achievement. 12 out of 27 articles were on the relationship of secondary school students` mathematics anxiety and their achievement.

There were 9 out of 27 articles which reviewed factors that can influence the secondary school students' mathematics anxiety. Furthermore there were 6 articles which reviewed both criteria. After analysing the articles and arranged to their categories, the articles were tabulated. This categories were illustrated in Table 1, which shows the research questions accurately and accordingly.

Table 1 Number of Study Based on Research Questions

Methods	Research Question 1	Research Question 2	Both Research Question
Quantitative study	11	8	5
Qualitative study	1	1	1
Total	12	9	6

Students are the main participant in the research related to 'mathematics anxiety' as they confront this situation. Considering the participants, it can be said that among those done with the group of students, most of the studies conducted for secondary school students. This point to an idea agreed that, at other stages, secondary school students were more nervous than other stage students. When performing the study random sampling approach was used.

Results

A general overview of the reviewed studies' outcomes is given in **Table 2**. The main outcomes of the studies are classified according to the research questions. This section reveals the relationship of secondary school students' mathematics anxiety and their achievement. Quantitative studies are the main criteria in this section of the review.

Table 2 The relationship of secondary school students' mathematics anxiety and their achievement in mathematic study

Method	Author (year)
Quantitative study n=11	Sharma (2016) Escalera et al (2016) Casem . (2016) Puteh M. and Khalin S. Z.(2016) Buratta (2019) Maria, et al (2016) Rameli, Kosnin,. (2017) Guita, Tan (2018) Reali et al (2016) Doruk, Öztürk, Kaplan (2016) Passolunghi et al.(2016)
Qualitative study n = 1	Oyegoke, Oyelabi,Nnaji (2016)

For the most part, papers were designed using quantitative methodology. Considering the data gathering tools used in these quantitative studies, it is seen that most of the articles uses scales. The majority of researches used anxiety scale in mathematics while some collected data with anxiety scale in mathematics. Most of the articles surveyed about the relationship of the secondary school students' mathematics anxiety and their achievement. The result shows the higher the mathematics anxiety the lower their achievements. The articles were mainly related to many aspects such flipped instruction (Casem, 2016), cognitive performance (Buratta 2019), working memory (Maria. et al. 2016 ; Passolunghi 2016), development and validation (Rameli& Koslin, 2017), models and MARS scales (Sharma, 2016; Escalera 2016; Puteh 2016), self- efficacy (Doruk, Ozturk & Kaplan, 2016, Buratta, 2019) and reciprocal learning (Denis & Gibert, 2018). The higher the level of mathematics anxiety the lower the performance.

The Factors that can Influence Secondary School Students' Mathematics Anxiety

In this section the findings of factors that can influence secondary school students' mathematics anxiety was reviewed.

Table 3 The factors that can influence secondary school students' mathematics anxiety

Method	Author (year)
Quantitative study n=8	O'Keeffe, White, Panizzon, Elliott, & Semmens (2018) Delgado, Kassim (2019) Aksu, Gedik, Konyalioglu (2016). Bruce (2016) Vakili, K. (2017) García, Martínez, Santana (2018) Erdik (2018) Escalera , M. E., Rojas-, C. A (2019)
Qualitative n= 1	Poppy, Edy (2017)

There are 9 out of 27 articles about the factors that influence mathematics anxiety among secondary school students. The teacher's attitude and approach in the classroom has an effect on a learner's achievement as can be seen from results (Erdik ,2018), gender factor(Garcia, Martinez, Santana, 2018; Delgado& Kassim, 2019), self-efficacy (Aksu, Gedik, Konyalioglu, 2016), students perception (O'Keeffe, White, Panizzon, Elliott, & Semmens, 2018; Vakili, 2017).

Table 4 List of Review Studies of Relationship of Secondary School Students' Mathematics anxiety and Factors that Affect Their Mathematics anxiety and Their achievements in Mathematics (Both aspects)

Method	Author (Year)
Quantitative n = 5	Khatoon, Zinat (2017) Yavuz (2018) Ramirez (2018) Uysal , Selisik (2016) Ameen, Khaliq (2016)
Qualitative n = 1	Şad, S. N., Kış, A., Demir, M., & Özer, N.(2016)

Studies on mathematics anxiety and achievement show high mathematical achievement has to do with anxiety levels low mathematics or otherwise for low-level students to college level (Ramirez et al., 2013; Vukovic et al., 2013; Wu et. al., 2012; Veloo & Muhammad, 2011). Many studies indicate that mathematics anxiety contributes to the low achievement of mathematics students (Mohammad, 2017; Puteh & Khalin, 2016; Maloney et al., 2015; Karimi & Ventakesan, 2009; Iossi, 2009).

Students build up much of their mathematics knowledge in the classroom and their encounter with formal mathematics begin with their teachers. Besides this narrative evidence, a small number of quantitative studies have attempted to directly measure the relationship between mathematics anxiety of teachers and mathematics outcomes

of students. Mathematics anxious teachers and their use of unique teaching method have the ability to influence the mathematics achievement of students and their expectations of what their teachers believes in mathematics (Ramirez, 2018). Nevertheless, studies also note that there were no substantial association between mathematics anxiety and mathematic achievement (Gilner, 1987).

There is an inverse relationship between mathematics anxiety and academic achievement of the students. Students with a strong fear for mathematics have less academic success (Khattoon & Inat, 2017). Scores of anxiety in mathematics do not display significant differences by gender (Yavuz, 2018). The anxiety level of secondary school students lower than the anxiety level of vocational high school students and there was a significant difference between the students' level of anxiety by gender (Uysal & Selisik, 2016).

Studies also indicates that female students' are more anxious about mathematics than male students, rural students also showed more anxiety than urban area students (Ameen & Khaliq, 2016). Analysis of the moderator based on the school level showed that the overall effect size was significant, negative and moderate for middle school studies (Sad et al., 2016)

Discussion

Inconsistent findings in previous studies also led to the study about these mathematical concerns are always made. For over six decades (Dowker, 2016), many studies of mathematical anxiety have been carried out but studies that focus on student preparation levels are quite limited. Therefore, This study was conducted to fill the space left by the studies the past.

There are significant differences between students' mathematics achievement based on their level of mathematics anxiety. Excellent students have lower levels of mathematics anxiety, while students with lower mathematics levels have higher levels of anxiety. This is because outstanding students have a strong understanding of mathematics and have greater confidence than low-achieving students (Effandi, Normalizam, Nur Amalina and Ayu Erlina, 2012). These findings support the findings of Woodard (2004), and Karimi and Venkatesan (2009), who suggest that students with high levels of anxiety tend to have lower math scores. On the other hand, students with low levels of anxiety tend to score higher in math

A five-year study of 6- to 10-year-olds revealed that levels of mathematics anxiety were closely related to student achievement (Sherman and Wither, 2003). This is supported by the study of Elenchothy (2007), which shows the inverse relationship between math anxiety and student achievement. Interest and confidence in this aspect are very important in learning to reduce mathematics anxiety and ultimately be able to achieve good results in examinations (Zakariah 1997). Articles were based on methodological and theoretical issues. There were 24 articles out of 27 studies used quantitative method, 3 out of 27 studies used qualitative studies. It can be said that most of the studies were designed to the methodology of quantitative research. Though the findings show that scales were widely used as a method of data collection tool. Such quantitative research may be recognized as providing useful knowledge to the literature review.

Conclusion and Future Research

The issues investigated in this review were related to the relationship of secondary students' mathematics anxiety and their achievement in mathematics and the factors that can influence the secondary school students' mathematics anxiety. The result also agrees with the findings of Yakubu et al. (2019) that there exist a high negative significant relationship between test anxiety and /achievement in mathematics,

Through this analysis, key points are assumed to established for future research in relatin to mathematics anxiety. Since a descriptive picture of anxiety of mathematics and its review has been analysed in this study. Most of the research aimed at examining the achievement and the factors leading to mathematics anxiety. In addition to this, its relationship with genders, school types, the abilities of students and anxiety in mathematics are explored in some studies. In conclusion, anxiety of students in mathematics can be accessed or explained by their expectations but studies should take into account certain group of participants such as teachers, parents and friends. Based on the issues discussed earlier, it can be concluded that anxiety in mathematics occurs in the classroom due to the lack of consideration among students with different learning styles. Most students do not understand the subject is due to a rather tedious learning style. Teacher needs to diversify teaching and learning techniques so that students do not become bored at the same time reduce students' interest in mathematics subjects. Mathematics should also be seen positively to reduce anxiety among students about the subject. Mathematics subject should not be viewed as a burdensome subject they should learn how to use it.

Mathematics anxiety has been discussed for almost 60 years. This systematic literature review has explored the empirical studies based on mathematics anxiety throughout the world. Even though there are few studies that has been done based on this matter but this survey makes a significant contribution to research. Today's demand for a better achievement and performance in mathematics were directly linked to mathematics anxiety. The findings of this research lead to the creation and implementation of new techniques in the teaching-learning processes that contribute to reducing the levels of anxiety in the students who were the main focus of this study. This study therefore proposes to add empirical data on mathematical anxiety and its effect on the teaching and learning of mathematics in secondary schools and, in particular, to present empirical data on mathematical anxiety and its effect on the teaching and learning of mathematics in secondary schools. Mathematical anxiety results are still too scarce to draw firm conclusions based on accumulated, reliable data across studies. It is proposed that studies be performed explicitly in other areas of secondary schools for future study and more on qualitative and mix method approaches. There are some important contributions from this article. Firstly this article emphasises on the effects of mathematics anxiety towards the achievement of students and also the factors. This can be used a make a conclusion how we can give more concern to mathematics anxiety. Secondly this article gives an example of how a systematic review can be conducted. Researcher hopes this will inspire other researchers to conduct rigorous, reproducible and clear reviews in the future within our mathematic education. There is obviously a need for further studies in this field to be carried out.

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