

# Mathematics Anxiety: Causes and the Effects on Student's Mathematics Achievement

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**Abstract.** The purpose of this study was to describe the causes and effect of mathematics anxiety on student's mathematics achievement. Total of 10 articles were included in this study to analyze the causes and the effects of mathematics anxiety on student's mathematics achievement. The result of the study is that mathematics anxiety can be seen as a progressive thinking and as a regressive thinking. Mathematics anxiety is affected by mathematics instruction, student's attitudes towards mathematics, student's past mathematics experiences, and student's belief. Mathematics anxiety can facilitate student's mathematics achievement, debilitate student's mathematics achievement, or can be unassociated with student's mathematics achievement, depends on the diversity of student's characteristics. Nevertheless, the majority of articles state that mathematics anxiety has inverse relation to student's achievement. Some suggestions were made according to the research findings.

## INTRODUCTION

Mathematics is one of the subject studied since primary education to higher education, because mathematics is hierarchical, to learn new topics, students need to master the prerequisite first. Mathematics skills are important for daily life, but many people feel anxious when faced with the prospect of doing mathematics. This anxious towards mathematics called mathematics anxiety. Various research is conducted related to mathematics anxiety. Some of the results shows that mathematics anxiety affects students motivation, learning effort, independence, performance on mathematics course, and student's mathematics achievement [1]. Mathematics anxiety often related with mathematics achievement. Many research conducted on the relationship between the mathematics anxiety and mathematics achievement. Ma found that the relationship between mathematics anxiety and mathematics achievement is significant [2]. This paper aimed to examine the causes and effect of mathematics anxiety on student's mathematics achievement based on studies that have been done by previous researchers on the causes and effects of mathematical anxiety on mathematics achievement.

Achievement can be defined as knowledge, skill, abilities, and progress that students have developed as a result of instruction [3][4]. Robert and Chair defined student achievement as the status of subject-matter knowledge, understandings, and skills at one point in time most commonly used measure of student achievement is a standardized test [5]. Johnson and Johnson states that achievements are related to behaviour such as the ability to communicate, cooperate, conduct activities and solve complex problems [6]. Specifically, Watson defined mathematics achievement as the exploitation of the human mind to understand and enjoy mathematics [7].

Students' Mathematics achievement is affected by many factors including their ages, gender, developmental levels, intelligence, interests and needs, environment and teachers, attitudes towards mathematics, senses of self-efficacy, anxiety, motivation, pre-existing knowledge and students' relationship with each other [8]. Though there are many factors associated with or affecting the students' mathematics achievement, especially mathematics anxiety has attracted the attention of many researchers for its association with mathematics achievement.

Anxiety refers to a psychological state in which the person's sense of uneasy suspense and worry is triggered by ambiguous circumstances [9]. Mayer states that everyone experiences anxiety, many adults and children experience quite a bit of stress in their daily lives that can lead to more anxiety [10]. There is two type of anxiety, state and trait anxiety [9]. State anxiety refers to the immediate feelings of being anxious, such as nervousness

and bodily tension. Trait anxiety refers to individual characteristics who tend to have anxiety. Some individuals are more easily made anxious than others and are said to be high in trait anxiety. Related to state and trait anxiety, there is test anxiety. Test anxiety is a unique anxiety that occurs when an individual will take a test or assessment. The more test-anxious a person is (trait), the stronger he or she experiences stress when facing a testing situation (state) [11]. Test anxiety often associated with academic activities, especially mathematics assessment.

Mathematics anxiety is anxiety related to mathematics. Mathematics anxiety is a form of state anxiety. Specifically, many researchers have described the notion of mathematical anxiety. Sousa described mathematics anxiety as a feeling of tension that interferes with the manipulations of numbers and the solving of mathematical problems in academic and ordinary life situations [12]. Richardson and Suinn defined mathematics anxiety as feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations [13]. Brady and Bowd defined mathematics anxiety as being uncomfortable in performing mathematical tasks in non-formal classroom situations, avoiding formal mathematical instruction whenever possible, poor test performance and the utilization of remedial instruction to little effect [14].

The other description of mathematics anxiety are “mathematics anxiety is an anxious state in response to mathematics-related situations that are perceived as threatening to self-esteem” [15], “an intense emotional and irrational fear of mathematics based on unrealistic feelings of frustration, hopelessness, and helplessness associated with repeated failure or lack of experience of success” [16], “an illogical feeling of panic, embarrassment, flurry, avoidance, failing and fear, which are physically visible, and which prevent solution, learning and success about mathematics” [17]. Based on the expert’s definition of mathematics anxiety, in summary mathematics anxiety is the student’s reaction in the form of fear, tension, anxiety, and feelings of discomfort when facing mathematics both when taking classes in class, or in everyday life.

Mathematics anxiety often related to test anxiety. However, Richardson and Woolfolk states that mathematics anxiety not only focuses on mathematics assessment but also concerns mathematical content, its distinctive features as an intellectual activity, and its meanings for many persons in our society. The difference between mathematics anxiety and test anxiety are individual with test anxiety more likely feeling threatened and stressful over examination, and individual with mathematics anxiety more likely feeling threatened and stressful over number manipulation, and everything related to mathematics [9].

Mathematics anxiety can be seen as anxiety as progressive thinking dan anxiety as regressive thinking. If anxiety encourages students to move forward, diligently studied, then anxiety is a good thing. These days’ mathematics anxiety is perceived as a negative feeling regarding mathematics, even though there are some positive effect of mathematics anxiety. Thus anxiety over mathematics is more often seen as regressive thinking. Students who have anxiety toward mathematics tend to stay away from mathematics problems by dodging and neglecting about mathematics. Mathematics anxiety affected not only affected students, many studies shows that mathematics anxiety also affected pre-service and in-service mathematics teachers. Richardson and Suinn stated that mathematics anxiety may prevent a student from passing fundamental mathematics courses or prevent advanced pursuing courses in mathematics or the sciences [13]. Berch and Mazzocco revealed that students with mathematics anxiety have tendency to avoid mathematics both in school nor their career paths [18]. Research conducted by Vukovic, Kieffer, Bailey, and Harari shows that mathematics anxiety may detect not only how young children perform mathematically, but also how much mathematics some children learn [19].

## **METHODOLOGY**

This study is a literature study to describe the causes and effect of mathematics anxiety on student’s mathematics achievement. More than 10 articles were included in this study to analyse the causes and the effects of mathematics anxiety on student’s mathematics achievement. The studies differed across a broad range of properties and features such as school grade level, ability levels, and the research designs.

## **RESULT AND DISCUSSION**

### **The Causes of Mathematics Anxiety**

There are several studies on the cause of mathematics anxiety. Hadfield and McNeil separated the causes of mathematics anxiety into three categories: environmental, intellectual, and personality factors [20]. Environmental factors include negative experiences in the classroom, parental pressure, insensitive teachers, and non-democratic and non-supportive class environment. Intellectual factors include negative attitude, low persistence, self-doubt, and lack of confidence in mathematical ability. Personality factors include reluctance to ask questions due to shyness, lack of self-respect and gender bias.

Harper and Daane research about causes of mathematics anxiety shows that the instructional practices of teachers influenced mathematics anxiety [21]. Their study shows that each factor on the survey concerning past experiences in mathematics had a direct influence on the mathematics anxiety. Harper and Daane states that the cause of this anxiety has begun in elementary school, and often the anxiety has been created by the teacher. They also state that many of the causes of math anxiety have stemmed from rigid and structured classroom instructional practices. Students have often felt under pressure to do math in an allotted amount of time and to do it the "right" way.

Bekdemir hold some interviews in his research related to mathematics anxiety. The responses to the interview question about past influences on Bekdemir research were categorized into four groups: instructor's hostile behaviour, inadequacy of instructors, peer pressure, and school and surrounding context [17]. His research on the relationship between mathematics anxiety and student's experiences on mathematics classroom summarized that one of the cause of mathematics anxiety is teacher's instructional classroom. Bekdemir research shows that instructors' hostile behaviour, examination anxiety, find that instructor's physical and verbal interactions make students feel uncomfortable and insecure. Students feel uncomfortable by mathematics teacher behaviours such as scolding, disgracing, making fun of students, scorning, threatening and punishing, being rigid, insensitive, and uncaring, treating students unfairly and inconsistently. Some researchers find that teacher's traditional ways of teaching also raising student's mathematics anxiety. Teacher that rarely using different teaching and learning method also makes students bored and uncomfortable.

Researchers also believe that students negative attitude towards mathematics nevertheless the underlying causes of student's mathematics anxiety. To some, mathematics is pointless and irrelevant and they will not bother with it if they can avoid it, while to others, mathematics is fascinating and a source of never-ending delight. Mathematics has a negative image in the society. There is common judgement that mathematics is complicated, incomprehensible thing, and not many people are able to learn mathematics well. This image of mathematics lead students has negative attitude towards mathematics. Harper and Daane research shows that math anxiety was caused by an emphasis on the right answers and the right method, fear of making mistakes, frustration at the amount of time it took to do word problems, an emphasis on timed tests, feeling dumb when unable to solve a mathematics problem, and having no confidence in their mathematics ability [21]. That's why students pressured to do mathematics in the right ways. They feel that mathematics is too rigid, that there is almost no gap to innovating in mathematics. Negative attitude towards mathematics includes feeling uneasy and tense when talking and hearing about mathematics. Students holding this attitude believe mathematics is strange and too complicated. Furthermore, some students are scared or worried about mathematics [17]. That why teachers should use innovative teaching and learning methods to reducing the negative image towards mathematics.

Beside of the negative attitude towards mathematics, students past mathematics experiences also influencing student's mathematics anxiety. Harper and Daane hold interviews to the students to unveil more specific information about past experiences which led to mathematics anxiety and the influence of the methods course. The responses to the interview question about past influences causing math anxiety yielded four topics: specific math content, teacher instruction and attitude, specific episodes in math classes, and aspects not directly related to the math classroom. The result of the interviews also shows that there were some aspects that were not directly related to the mathematics classroom that caused anxiety. These included a slowness for learning, dyslexia, and parental pressure to do well in mathematics [21]. Mathematics anxious persons tended to feel helpless, fearful, insecure, inferior, and not confident about their mathematics ability. These feeling coincided with their beliefs, for example, they were just not good at mathematics and they could never work hard enough to do mathematics well. Many believed they lacked an understanding of mathematics and that mathematics was not useful [21].

Hoffman summarized that the origins of mathematics anxiety differ broadly, but are frequently linked to lower ability perceptions, prior unsuccessful experience, maladaptive attributions, lack of study and test preparation skills, and situational affective factors such as the perception of autonomic and somatic arousal, or increased worry [22]. Şad, Kış, Demir, and Özer also summarized that some factor such as gender, the school that students attend, grade level, teacher behaviors, previous school experiences, and parents' educational background cause significant differences among students' Mathematics anxiety [8]

The origins of mathematics anxiety differ broadly, whether the causes of mathematics anxiety giving a positive or negative effect on student's mathematics anxiety. But some researcher generally approves on some causes of mathematics anxiety, which is mathematics instruction, student's attitudes towards mathematics, student's past mathematics experiences, and student's belief.

### **The Effect of Mathematics Anxiety on Student's Mathematics Achievement**

Research shows there is relationship between mathematics anxiety and achievement, gender, also age. Some studies show that mathematics anxiety is experienced differently by the different gender within a classroom. It

said that mathematics anxiety affected female students more than male students. Males' mathematics anxiety was strongly related to general test anxiety, whereas females' mathematics anxiety levels were related to their perceived mathematics ability and an increase in their standardised achievement test scores [23]. Taylor and Fraser research also shows that females students were more anxious than males regarding testing of mathematical concepts, male's students were more anxious than females regarding the learning of mathematics [24]. Some studies show that in early grades, there is no different level of mathematics anxiety between male and female students, and in the higher grades (in the secondary school and college), female students show higher level of anxiety the male students.

Ma's meta-analysis research shows that that the relationship between mathematics anxiety and mathematics achievement was similar for males and females, the relationship was consistent across the three grade-level group (elementary, middle, and high school), the relationship was consistent between mixed and unmixed ethnic groups [2]. Ma's finding do not support any other finding that mathematics anxiety differs based gender. Ma's research also shows that mathematics anxiety consistent across the three grade-level group (elementary, middle, and high school). Based on his finding's the difference on mathematics anxiety shown when using commercially developed achievement and using mathematics teachers' grades and researcher-designed mathematics tests. The teacher and research designing test shows more correlation than using commercially developed ones.

The result of Hembree studies shows that correlations between mathematics anxiety and aptitude/ achievement measures were inverse across grade levels, so higher mathematics anxiety consistently related to lower mathematics performance [1]. In Grades 5-12, the inverse relation was stronger for males than females, a difference that disappeared among college students. Grades in mathematics courses seemed depressed in relation to anxiety by about the same proportion as the students' test scores.

Woodrard research about relationship between mathematics anxiety, gender, and mathematics achievement shows that there is negative relationship between mathematics anxiety and final exam, which means when mathematics score increase, mathematics achievement scores decrease. The research also indicate that female students are significantly more mathematics anxious than male students [25].

Sad and Kis's meta-analysis research shows that as the students' level of anxiety towards mathematics increases their mathematics achievement decreases, or as their level of anxiety decreases their mathematics achievement increases. Their finding can be interpreted vice versa suggesting that an increase in mathematics achievement can reduce students' mathematics anxiety, or a decrease in mathematics performance can increase mathematics anxiety. Thus, it can be suggested that the correlation between mathematics anxiety and achievement have a reciprocal or cyclical nature [8].

Sad and Kis's research also shows that the comparison of the common effect sizes of the studies conducted at middle and high school levels revealed that the negative correlation between mathematics anxiety and achievement affects middle school students more strongly than high school students [8]. It can be said that mathematics anxiety felt by the middle school students affects their Math performance more adversely compared to its effect on the mathematics performance of high school students. Likewise, the impact of mathematics achievement on middle school students' math anxiety is stronger compared to high school students. Hunt concluded that there are evident differences between males and females in mathematics anxiety and that researchers need to examine the reason females are more anxious about mathematics than their male counterparts.

There are so many studies on mathematics anxiety and mathematics achievement. Some study shows completely different results than the other ones. Some research shows that there is no significant relationship between mathematics anxiety and mathematics achievement, which means even if students has high level of mathematics anxiety but their mathematics achievement level doesn't show that low grades. More research shows that there is completely inverse relationship between mathematics anxiety and mathematics achievement, which means if students level of mathematics anxiety is high then their mathematics achievement is relative low and if their level mathematics anxiety is low then their mathematics achievement is relatively high. Contrary to the two finding, there is also research that shows that there is no relationship between mathematics anxiety and mathematics achievement. Mostly research finding shows that there is inverse relationship between mathematics anxiety and mathematics achievement.

Related to gender and grade level, many researches show that the level of mathematics anxiety for female students than male students and related to mathematics achievement, female students with mathematics anxiety shows lower mathematics achievement than male students. Related to grade level, most studies show that elementary students have the lowest level of mathematics anxiety. They are seems enjoying mathematics which resulted their mathematics achievement is relatively good. In the secondary level, students level of mathematics anxiety starts to differ. And in the high school level, more students show that they have high level of mathematics anxiety which resulted their mathematics achievement is relative poor.

## CONCLUSIONS AND SUGGESTIONS

The origins of mathematics anxiety differ broadly, whether the causes of mathematics anxiety giving a positive or negative effect on student's mathematics anxiety. But some researcher generally approves on some causes of mathematics anxiety, which is mathematics instruction, student's attitudes towards mathematics, student's past mathematics experiences, and student's belief. Mathematics anxiety can facilitate student's mathematics achievement, debilitate student's mathematics achievement, or can be unassociated with student's mathematics achievement, depends on the diversity of student's characteristics. Nevertheless, the majority of articles state that mathematics anxiety has inverse relation to student's achievement.

Based from the finding in this article, some it is suggested that teachers should hold an innovative teaching and learning activities in the class. Teachers should cautious when talking and behaving around students, because past teachers' behaviour and teaching approaches are the basic causes of their mathematics anxiety. Teacher also need to eliminate the other cause of mathematics anxiety in each level in each grade, because the negative effect of mathematics anxiety need to be eliminate as early as possible.

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