

## **Math Anxiety Effects on Elementary Aged Students**

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### **Abstract**

For many students, math can be seen as a challenging subject to grasp in school. The cause for this is a phenomenon known as math anxiety. Math anxiety can look different from student to student, but oftentimes students will feel anxious or uneasy when presented with a mathematical problem. In recent years several studies have been conducted to further our knowledge of math anxiety. However, much of this research has been focused on middle school-aged students and above. The following paper will discuss what math anxiety is, the theories behind it, list potential causes, adverse effects, and list interventions that have proven to be effective for students.

### **Math Anxiety Effects In Elementary Aged Students**

As stated above, math anxiety can look different from student to student. Siaw et al. (2020) explain, "Mathematical anxiety can be defined as fear, hopelessness, paralysis, and mental disorientation that emerges among some individuals when solving mathematical problems" (Siaw et al., 2020, p. 48). These feelings of fear and anxiety can also manifest into physical reactions in elementary-aged students. I have seen this be the case on several occasions in my fifth-grade classroom. Although I am only entering my third year teaching, I have already encountered several students who suffer from math anxiety. When these students were presented with math assessments they would report feeling anxious and also have physical reactions such as sweating or a stomach ache. Although the students I work with are only ten and eleven years old they have already developed a severe adverse reaction to math. The concerns around math anxiety are many. Teachers of elementary-aged students need to be aware of math anxiety and how to reduce it. If math anxiety is not addressed in elementary school, it can continue to compound and affect students more severely. The goal of my research is to discover why students at such a young age have developed math anxiety. I also wondered what the negative effects of math anxiety were. Finally, I was eager to discover proven interventions to help my students immediately.

In the next section, I will discuss theories related to math anxiety, underlying causes for math anxiety, and the negative effects of math anxiety.

### **Review of Research**

#### **Theories Behind Math Anxiety**

Upon further research into math anxiety, I discovered that there are three main theories related to math anxiety and mathematical performance in students. These three theories are The Deficit Theory, The Cognitive Interference Theory, and The Reciprocal Theory. Namkung et al. (2019) explain, "The

deficit theory posits that poor mathematics performance and memories of poor mathematics performance leads to higher math anxiety in the future” (Namkung et al., 2019, p. 462). In other words, a student's poor performance in math can affect their attitude towards math in the future. Namkung et al. (2019) also write, “The cognitive interference theory (also referred to as debilitation anxiety model) posits that it is math anxiety that affects subsequent mathematics performance. The interference mechanism lies in three ways, during preprocessing, processing, and retrieval of information” (Namkung et al., 2019, p. 462). With this theory, math anxiety can lead to students avoiding math-related activities and situations during preprocessing. For example, students with math anxiety enjoy math less and are less motivated and confident in the subject. This then leads to students being less likely to continue in educational paths that involve mathematics. Furthermore, math anxiety can cause cognitive interference. This means that feelings of worry and other intrusive thoughts caused by math anxiety hinder the working memory of students. Finally, Namkung et al. (2019) write, “According to the reciprocal theory, past failure and negative experiences in mathematics performance may lead to math anxiety, which subsequently leads to poorer mathematics performance, and vice versa” (Namkung et al., 2019, p. 462). In this theory, a student's experience and potential failures in math can lead to math anxiety, which in turn can lead to poorer mathematical performance.

### **Underlying Causes of Math Anxiety**

A question that guided my research was what are the causes of math anxiety. The students that I work with are general education students who are only ten and eleven years old but have somehow already acquired significant negative feelings about math. According to Ramirez et al. (2018), math anxiety is a complex trait to manipulate, so it can be difficult to pinpoint. Currently, theories designed to explain the development of math anxiety falls broadly into one of three categories: poor math skills, genetic predispositions, or socio-environmental factors. As cited by Ramirez et al. (2018), in a study completed in 2004 by Ma and Xu, researchers found that higher math anxiety in previous years predicted lower math achievement in later years. Additionally, lower math achievement in previous years predicted higher math anxiety in the following years.

This result falls into the category of poor math skills leading to math anxiety. (Ramirez et al., 2018). Another factor that can affect one's likelihood to develop math anxiety is genetics. In 2014, Wang published an empirical research study that sought to answer the question of how genetics contribute to math anxiety. The researchers looked at math anxiety by studying a group of twin adolescent siblings. They found that genetic factors accounted for roughly 40% of the variation in math anxiety (Ramirez et al., 2018). Finally, socio-environmental can play a role in causing math anxiety as well. One cause can be a teacher who experiences math anxiety themselves. Children often get their first experiences with math from inside the classroom and this can have a negative effect if their teacher is not confident in math. Ramirez et al., (2018) write, “A common theme across studies is that teachers’ math anxiety contributes to children’s math anxiety through their use of particular pedagogical practices (Allen, 2001; Chapline, 1980; Chavez & Widmer, 1982; Markovits, 2011), such as overemphasizing rote learning instead of more conceptual activities (Trujillo & Hadfield, 1999; Vinson, 2001) or presenting lessons in a more dogmatic manner (Ball, 1990)” (Ramirez et al., 2018, p. 150). This finding both shocked and resonated with me greatly. As educators, our feelings and anxiousness about math could lead to students experiencing math anxiety.

### **Negative Impacts of Math Anxiety**

Several studies have shown that math anxiety affects students' math performance. However, a bulk of these studies have focused on middle grades students and above. A study completed by Szczygieł (2020) aimed to provide additional data on the nature of math anxiety in elementary-aged students. Specifically, the study examined whether or not math anxiety was related to math achievement in Polish first through third graders. Szczygieł's (2020) research results confirmed that math anxiety is negatively related to math achievement in children from first to third grade. Another study completed by Tomasetto and colleagues (2021) aimed to investigate whether or not math anxiety affected students' ability to encode new math knowledge. Their study consisted of presenting 6-year-old children with two contents that had not yet been covered in the curriculum before the study. They found that math anxiety was negatively related to the initial level of knowledge in the case of three out of four math contents. Additionally, anxiety was also negatively related to the rate of learning in two out of four tasks. This evidence hints that math anxiety may reduce the encoding of new math knowledge in memory of very young children which could potentially lead to gaps in math proficiency for children with math anxiety from the very beginning of their formal education (Tomasetto et al., 2021). Another impact of math anxiety on students is that it can affect their career choice later on in life. Barroso et al., (2021) argued that high levels of math anxiety, as well as low math achievement and beliefs about math ability early in early childhood, significantly relate to avoidance of later educational interactions with math. One study found that students who had low or decreasing math anxiety from middle school through high school were more likely to choose STEM majors than students who had consistently high math anxiety (Barroso et al., 2021, p. 135). Furthermore, math anxiety can affect students' working memory. Dowker et al. (2016) believed that math anxiety might also influence students' math performance by overloading their working memory.

Dowker et al. (2016) write, "Anxious people are likely to have intrusive thoughts about how badly they are doing, which may distract attention from the task or problem at hand and overload working memory resources" (Dowker et al., 2016, p. 4). As cited by Dowker et al. (2016), a study conducted in 2001 by Ashcraft and Kirk found that people with higher math anxiety demonstrated smaller working memory spans than people with less math anxiety, especially in tasks that required calculation. In this particular study, people with math anxiety were much slower and made more errors than others in tasks where they had to do mental addition at the same time as keeping numbers in memory. (Dowker et al., 2016).

## **Discussion**

### **Interventions**

As shown by the research above, math anxiety in elementary-aged students can have a significant negative impact. After learning about this, I was personally invested in investigating interventions that were proven to be effective for anxiety. I specifically was looking for interventions that would benefit elementary-aged students and could be used in the general education classroom. During my research, I noticed that several interventions were centered around mindfulness techniques. LaGue et al. (2019) define this as, "Mindfulness-based cognitive therapy is a method involving a decentering of one's self to observe and evaluate cognitions, emotions, and physical sensations through a nonjudgmental lens in which events are described, rather than changed" (LaGue et al., 2019, p. 143). LaGue and colleagues conducted a study to explore whether mindfulness-based cognitive therapy (MBCT) could be expanded to the treatment of math anxiety. In their study, three high school students who were assessed with high levels of math anxiety met individually twice a week for six weeks with the school counselor. The

school counselor used a manualized MBCT treatment for anxiety as the intervention. Activities in this intervention included sensory-based practices, seated breath meditations, mindful movement activities, body scans, visualization practices, and drawing or writing. The results of the study showed a decrease in math anxiety for all three participants that were included in the study. (LaGue et al., 2019). This study provided evidence that mindfulness-based cognitive practices could be used to assist with lessening students' math anxiety. Knowing this, I began to look for interventions that would be easily used in the general education elementary classroom. A brief, easy-to-implement intervention is mindfulness art-making. Carsley & Heath (2019) write, "Mindful art-making is hypothesized to combine the creative manipulation of materials found in art-making (e.g., Abbott, Shanahan, & Neufeld, 2013) with the benefits of mindfulness meditation (Curry & Kasser, 2005)" (Carsley & Heath, 2019, p. 144). In their study, they compared the effectiveness of coloring mandalas versus a free draw activity in the reduction of test anxiety in elementary-aged students. Their findings showed that students in both the mindfulness (mandala coloring) and free draw coloring group reported reductions in test anxiety. (Carsley & Heath, 2019). So, it can be concluded that mindfulness coloring activities, like coloring mandalas, can help reduce test anxiety when used before a test.

Another intervention that came up in my research was the use of mindfulness-based yoga. Stapp and Lambert (2020) recently conducted a study to measure the effectiveness of mindfulness-based yoga techniques on fifth-grade students' perceived anxiety and stress. In their study, students participated in a guided breathing exercise and basic yoga poses (downward dog, butterfly pose, and tree pose) for five minutes at the beginning of each class period. Their study concluded that in all three classes in which the mindfulness-based yoga intervention was used, there were decreased levels of perceived stress. However, their study found that males in the remedial class benefited the most with an average decrease of 16.67% in perceived anxiety levels and an average decrease of 31.58% in perceived stress levels. (Stapp & Lambert, 2020). As a result, mindfulness-based yoga techniques can be used as an intervention for test anxiety in elementary-aged students.

What extent do teachers play in students' math anxiety? This is an area that I would love to see more research on. It would be interesting to see how a teacher's attitude and self-efficacy regarding math related to their students' perceived math anxiety. Furthermore, are a teacher's feelings toward math more critical in early elementary as students are presumably more impressionable?

## **Conclusion**

All around, the research that I discovered assured me that math anxiety is a significant issue that needs to be addressed in the classroom. Through my research, I discovered that math anxiety not only affects older students but elementary-aged students as well. In the context of elementary-aged students, math anxiety has significant negative impacts related to mathematical performance, working memory, and the ability to learn new math content that can lead to cognitive gaps in subsequent grades. However, mindfulness-based interventions have been proven to be effective with students with math anxiety. Such interventions include mindfulness coloring and yoga. Both of these interventions are easily replicated in the elementary classroom yet can have significant reductions in anxiety and stress among students.

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