

Intergenerational Transmission of Math anxiety: Discussion About Research of Parents' and Children's Math Anxiety

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Abstract. Math is an abstract and challenging subject, so students may have math anxiety when studying math. Math anxiety might be transmitted intergenerationally. This article discusses research on math anxiety's intergenerational transmission in three aspects. The first aspect is the factors of parents influencing children's math anxiety levels. These factors are parents' math anxiety, intelligence mindset, parent-child relationships, and parental educational involvement. The second aspect is the influence of parental math anxiety on children. Parental anxiety can influence children's math anxiety, math outcomes, and how much math they learn, and it can affect children as early as kindergarten age. The third aspect is the methods and interventions reducing children's math anxiety and improving outcomes. Stopping parents with high math anxiety levels, using math applications involving interaction between parents and children, changing fixed mindset to growth mindset, and doing mindfulness are all interventions that can help reduce children's math anxiety. In conclusion, the intergenerational transmission of math anxiety is critical and represented by factors of parents influencing children's math anxiety level and the influence of parental math anxiety on children. Parents should use appropriate ways to reduce their children's math anxiety. Further research should focus on the cause-and-effect relationship between parents' math anxiety and children.

Keywords: Parental Math Anxiety; Child Math Anxiety; Intergenerational Transmission; Intervention.

1. Introduction

With the development of the education system, math anxiety is becoming a noticeable problem for students and their parents. Math is an essential subject for many fields of science, including physics, chemistry, and social sciences. To improve students' math levels, students in many countries and regions start to learn math very early. However, learning math also brings some problems. Because math is an abstract and challenging subject, it might be hard for some students to learn it, so some students become anxious when learning math. This anxiety of students is called math anxiety.

There is a variety of definitions of math anxiety. According to Suárez-Pellicioni et al., the common point of different definitions of math anxiety is that it is an emotional reaction of some people solving math problems that can damage their math performance, and it emerges as early as age six to nine [1]. People affected by math anxiety might avoid taking math courses and finding a job involving math skills [2]. Usually, a high level of math anxiety relates to poor math performance, and two theories explain the cause-and-effect relationship between math anxiety and poor math performance. The deficit theory states that being aware of past poor math performance makes math anxiety appear, while the debilitating anxiety model states that a high math anxiety level can lower math performance [2].

Many factors can influence students' math anxiety levels, and one of the most critical factors is the math anxiety of students' parents. According to Suárez-Pellicioni et al., students' attitudes toward math usually depend on their parents' attitudes toward math [1], so the intergeneration transformation of math anxiety is likely to happen. According to many studies, parents' math anxiety can influence their children in many ways, and many factors on parents can affect their children's level of math anxiety. This field of intergeneration transformation of math anxiety is becoming interesting because understanding math anxiety's intergeneration transformation can help parents and their children reduce math anxiety at family levels and make their math performance further develop.

At present, there are many relatively complete studies on the impact of parents' math anxiety on children, but there is a lack of summary and arrangement of such studies. This article aims to analyze

how math anxiety transfers between generations by discussing factors of parents influencing children's math anxiety levels and the effects of parents' math anxiety on children. Moreover, the solution to poor math performance caused by math anxiety and the methods of reducing math anxiety of parents and children will be introduced.

This article will provide a comprehensive review and summary of the intergenerational transmission of math anxiety research. Based on this article, future research should focus on the interfering methods to reduce the math anxiety level of parents and children and ways to stop the transformation of math anxiety between parents and children, and a comprehensive system coping with math anxiety and helping students increase their math performance should be formed in the future so that they can learn math without anxiety and in a positive way.

2. Factors on Parents Influencing Children's Math Anxiety Level

2.1 Parents' math anxiety

There are many factors on parents influencing children's math anxiety. The first critical factor is parents' math anxiety and gender stereotypes. Parents' math anxiety can affect their children's math anxiety, and the effectiveness depends on the gender matching of parents and children. According to Casad et al., parents' math anxiety can influence the math anxiety of their children, and "Parents with lower math anxiety showed a positive relationship to children's math outcomes when children also had lower anxiety. The strongest relationships were found with same-gender dyads, particularly Mother-Daughter dyads" [3].

In the study of Casad et al., parents' math anxiety can influence their children's math anxiety, and it can be reflected in children's math outcomes, including self-efficacy in math, the grade point average of math, math behavioral intentions, attitudes toward math, and devaluating of math [3]. The influence of parental math anxiety is most significant in the mother-daughter pair [3]. When both mother and daughter have low math anxiety, the daughter will have good math outcomes [3]. On the other hand, when both mother and daughter have high anxiety, the daughter will have lousy math outcomes. Noticeably, the significant relationship between parental math anxiety and children's math grade point average is only found in the father-son pair [3]. When both the father's and son's math anxiety is high, the son's math grade point average is negative, and the son's math grade point average is positive in other situations [3]. Additionally, mixed-gender parent-child dyads are ineffective in math anxiety [3].

In the study of Szczygiel, the time when parents' math anxiety predicts elementary school children's math anxiety is examined [4]. According to Szczygiel, mothers' math anxiety level is not related to children's math anxiety level, "while an increase in the level of math anxiety in fathers was moderately associated with an increase in math anxiety in first graders. The moderating effect of gender in the math anxiety of adults and children was observed only in third graders and fathers" [4]. Fathers' math anxiety is positively correlated to daughters' level of math anxiety [4]. On the other hand, mothers' math anxiety is not related to children's math anxiety [4]. This result is too unique to confirm that parents' math anxiety can significantly affect children's math anxiety. This research rejects that adults directly transfer their math anxiety to children, and children's development of math anxiety is complicated, but math anxiety does transfer intergenerational in some ways. Furthermore, the relationship between parents' math anxiety and children's math achievement is also examined. The results show that mothers' math anxiety positively correlated with the math achievement of third graders, but this correlation is only found in students at the end of early school education [4].

Even if the study of Szczygiel and the study of Casad et al. have proved that parents' math anxiety does produce influence on children's math outcomes, it is still unclear if parents' math anxiety transfer to their children and how parents' math anxiety transfer to their children [3, 4].

2.2 Parents' Intelligence Mindset

Besides parents' math anxiety, parents' intelligence mindset also affects children's math anxiety. According to Xie et al. (2022), mindset can determine individuals' failure beliefs. People with a fixed mindset tend to avoid challenges to avoid failure, but people with a growth mindset do not. Parents' intelligence mindset can influence their children's intelligence mindset, and children's mindset may influence their math anxiety.

The study of Xie et al. shows that parents' intelligence mindsets do not directly influence children's math anxiety [5]. However, parents' intelligence mindsets can influence their evaluation of their children's math performance by affecting their failure mindsets [5]. This chain-mediated role of parents' intelligence mindsets is only found in parent-daughter relationships [5]. It only influences girls because of the gender stereotypes that boys are always better at math than girls [5]. Additionally, they also found a negative correlation between parents' evaluation of their children's math performance and children's math anxiety, and there is no gender difference [5].

2.3 The Parent-child Relationships and Parental Educational Involvement

Parents' relationships with their children and how they are involved in their children's education can also influence their children's math anxiety. The study by Ma et al. mainly focuses on "how parent-child relationships affect the math anxiety of children from a longitudinal view for the first time" [6]. After controlling the children's age, gender, learning, social anxiety, learning motivation, and math performance, they found that the father-child relationship can predict children's math anxiety negatively instead of the mother-child relationship [6].

One potential explanation is that fathers tend to emphasize the importance of math because they think they have a more valuable math self-concept, so better father-child relationships are related to less math anxiety. Another explanation is that a good father-child relationship can increase the sense of control and further decrease children's math anxiety, according to control-value theory. It means that a good father-child relationship can provide children with autonomy and controllability when they face math problems [6]. According to Ma et al., a father-child relationship is critical for interference in reducing children's math anxiety, and further research should focus on the mechanism of the influence of the father-child relationship on math anxiety [6].

In the study of Li et al., math anxiety was divided into two different types: learning math anxiety and math evaluation anxiety [7]. They found that "parental educational involvement negatively related to children's math evaluation anxiety through children's math learning involvement" because parental educational involvement is positively related to children's math learning involvement and children's math learning involvement negatively relates to their math evaluation anxiety [7]. Children's learning involvement totally mediates the relationship between parental educational involvement and learning math anxiety. Additionally, parental educational involvement can increase children's math investment and decrease math evaluation anxiety [7].

These are the factors of parents influencing children's math anxiety. However, many studies were conducted in China, and China is not a country that fits all western, educated, industrialized, rich, and democratic criteria, so the research results might not be appropriate to be generalized. More research needs to be conducted in this field to ensure that the influence of parents on children's math anxiety does exist and can be generalized to more countries and regions.

3. The Influence of Parental Math Anxiety on Children

3.1 Children's Math Anxiety and Math Outcomes

The influence of parental math anxiety on children is mainly on children's math outcomes and math anxiety, and its influence on children's math anxiety is reflected by its influence on children's math outcomes. According to Casad et al., parents' anxiety is also negatively related to children's math outcomes [3].

Maloney et al. found that parental math anxiety can influence children's math anxiety and math outcomes, which is mediated by parents' helping behaviors with children's math homework [8]. Parental math anxiety is negatively correlated with their children's math outcomes when parents often help their children finish math homework. This is proved because, as a control group, parental math anxiety is not related to children's reading achievement. An explanation mentioned by Maloney et al. is that parents who have a high level of math anxiety tend to believe that math is useless and have low math self-efficacy [8]. They are likely to conduct their negative attitudes toward math to their children when helping their children do math homework, so their children are likely to have low math motivation and reduce their investment in math.

Moreover, according to Maloney et al., "even if parents are competent in the type of basic math that first- and second-grade children encounter, this does not preclude them from having feelings of anxiety when faced with their children's math homework", so parents can also transmit their math anxiety to their children when their children are in first- and second grade [8]. However, most parents in this research are female, so this research result cannot provide how different gender parents conduct math anxiety to their children and be influenced by gender stereotypes that females are not good at math, so further research should focus on how father's math anxiety influence children through helping children do math homework.

3.2 How Much Math Children Learn

Parental math anxiety not only influences their children's math anxiety and outcomes but also influences how much math their children learn. According to Schaeffer et al., parents' math anxiety is positively related to how much math their children learn from first to third grade [9]. Their research used an application to mediate the relationship between parental math anxiety and children's math outcomes. For the family that cannot use the application, children with higher parental math anxiety spend less time studying math than children with lower parental math anxiety [9].

However, according to Schaeffer et al., the sample size, including 1000 individuals, is too small, and research in the future should increase the sample size to ensure this research is reliable [9]. However, the intervention in this research is an application, so it may be hard to repeat the experiment since the application is unique.

3.3 Parents' math anxiety can affect children as early as kindergarten

As discussed above, parents' math anxiety can influence their children's math anxiety, outcomes, and how much math children learn. However, when parental math anxiety starts to influence their children is also important to understand the transgenerational transmission of math anxiety. According to Becker et al., the influence of parental anxiety on children can be found as early as in pre-kindergarten children [10].

Previous research found a relationship between math anxiety and math performance in kindergarten, first-, second-, and third-grade children. In the study of Becker et al., many studies on math anxiety focus on adults and college students, but math anxiety can also be found in kindergarten children [10]. Due to these children's math experiences mostly depending on parents and teachers, the math anxiety of parents and teachers might be very important for the development of kindergarten, first-, second-, and third-grade children [10]. Moreover, because of the gender stereotype that males are better at math than females, children's math anxiety might be influenced by their gender.

Becker et al. found that parental math anxiety is significantly related to the math outcome of kindergarten children [10]. However, Becker et al. found that parental math anxiety's relationship with boys and girls does not significantly differ [10]. It means that the gender stereotype has yet to influence kindergarten children. However, the information about parental math anxiety was collected by self-report, so these parents might think they have lower math anxiety than they really have [10]. In future research, a more reliable way should be used to collect information about parental math anxiety.

Due to the influence of parental math anxiety on children in pre-kindergarten, providing two-generation intervention for families might be a good way to solve the problem [10]. It can reduce parents' math anxiety and improve children's math performance, and further research needs to be conducted to find the appropriate intervention.

4. Methods and Interventions Reducing Children's Math Anxiety and Improve Outcomes

One of the most important aims of researching the intergenerational transmission of math anxiety is to help parents and children reduce their level of math anxiety and enhance their math outcomes, and many contemporary studies have found many ways to reduce math anxiety.

As discussed in the study of Maloney et al., parents often receive information from schools that their involvement in children's education can help them succeed [10]. However, according to the research of Maloney et al., children receiving help from parents who have a high level of math anxiety are likely to have lower math outcomes, so reducing the math anxiety level of parents who often help their children do math homework can improve children's math outcome [10]. Moreover, parents who have a high level of math anxiety stop helping their children do math homework may also increase their math outcomes, so parents need to help their children in an appropriate way to improve their children's math achievement.

According to Schaeffer et al., using a math application involving interaction between parents and children can provide quality parent-children interaction [9]. This kind of interaction may change parents' attitudes toward math and further reduce the influence of their math anxiety on their children. However, this intervention involves using technology so that it can be used in western, educated, industrialized, rich, and democratic countries and regions. For some countries and regions that do not develop very well, this intervention cannot be used due to technical issues.

Furthermore, mindfulness intervention and intervention in changing people's mindsets can help them reduce their math anxiety levels. In the study of Samuel and Warner, math anxiety can exhaust the working memory load, and mindfulness can prevent math anxiety from exhausting working memory [11]. People who have a fixed mindset tend to pursue performance in the learning process. However, people with a growth mindset focus on the learning process itself, so usually, people with a growth mindset can have less math anxiety [11]. Moreover, people with less self-efficacy tend to be more anxious about math [11].

To ensure the cause-and-effect relationship between math anxiety and mindfulness, growth mindset, and self-efficacy, Samuel and Warner created an intervention that can help students do mindfulness, develop a growth mindset, and increase math self-efficacy [11]. Then they gave the intervention to college students who were learning math [11]. Comparing to students who do not receive the intervention, the math anxiety of people receiving the intervention significantly decreased in a year, so mindfulness, growth mindset, and math self-efficacy do cause a reduction in college students' math anxiety levels [11]. However, this experiment was only conducted on college students, so the effectiveness of these interventions on parents and their children is still unknown. Further research should be conducted on parents and children to see the effectiveness of this experiment.

5. Conclusion

In conclusion, the intergenerational transmission of math anxiety is mainly represented by factors of parents influencing children's math anxiety level and the influence of parental math anxiety on children. This transmission is critical because it starts as early as kindergarten [10]. To reduce children's math anxiety and improve their mat outcomes, parents should find an appropriate way to teach their children math and use a math application that includes many parent-child interactions. Moreover, mindfulness, a growth mindset, and math self-efficacy can also help reduce math anxiety and improve math outcomes.

One of the limitations of this analysis is that many studies are correlation studies and did not find the cause-and-effect relationship between parents' math anxiety and children. Further research should focus on the experiment that can prove the cause-and-relationship between math anxiety of parents and children and the inner mechanism of math anxiety's intergenerational transmission. Another limitation of this analysis is that genes might also play a role in intergenerational transmission, but almost no research has been done on the genetic transmission of math anxiety. In the future, the research may focus on genes to find a genetic inheritance of math anxiety.

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