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PSYCHOLOGICAL FACTORS OF MATHEMATICAL ANXIETY OBSERVED IN STUDENTS WHILE SOLVING MATHEMATICAL PROBLEMS

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Abstract. This article analyzes the psychological essence of mathematical anxiety manifested in the process of solving mathematical problems, as well as its impact on attention, working memory, self-confidence, and academic performance. The analysis of scientific sources shows that mathematical anxiety has a stable negative correlation with success in mathematics, and that this effect becomes stronger especially when students perform complex problems and problematic tasks. In addition, the article highlights that such factors as teacher support, the learning environment, previous experience, family-related factors, and a growth mindset significantly influence the level of mathematical anxiety. The paper also offers psychological and pedagogical recommendations for educational practice.

Keywords: mathematical anxiety, mathematical problem, working memory, attention, performance, student psychology, problem, solution, fear, anxiety, lack of confidence.

Introduction

In recent years, one of the most widely discussed issues in the psychology of mathematics education has been mathematical anxiety. It is regarded not only as emotional discomfort, but also as an important psychological factor influencing a student's engagement in mathematical activity, understanding of a problem, selection of a solution strategy, and achievement of the final result. The fact that more than 400 articles on mathematical anxiety among primary school students were published between 1979 and 2024 demonstrates the global relevance of this issue.

Mathematical anxiety is usually defined as a state of fear, tension, uneasiness, and self-doubt that arises in situations related to mathematics. According to PISA 2012 data of the Organisation for Economic Co-operation and Development (OECD), 59 percent of students in OECD countries reported that they often worry that mathematics lessons will be difficult, 33 percent stated that they become very tense while doing mathematics homework, and 31 percent indicated that they become very nervous when solving mathematical problems. These figures show that mathematical anxiety is not a phenomenon specific only to some students, but rather a psychological problem directly related to the mass education process.

The purpose of this article is to analyze, from a psychological perspective, the impact of mathematical anxiety on students' thinking processes and performance in the process of solving mathematical problems, to clarify its main mechanisms, and to develop practical recommendations aimed at reducing anxiety.

Research Methodology

The article is theoretical and analytical in nature. It comparatively analyzes contemporary scientific articles, meta-analyses, and reports of the Organisation for Economic Co-operation and Development (OECD) related to mathematical anxiety, working memory, mathematics achievement, and the educational environment. In particular, the study is based on meta-analyses summarizing the relationship between mathematical anxiety and achievement, research devoted to the mediating role of working memory, as well as international data demonstrating the influence of teacher support and thinking style.

Main Part

1. The Relationship Between Mathematical Anxiety and Achievement

Scientific literature has identified a stable negative relationship between mathematical anxiety and success in mathematics. A meta-analysis covering 84 samples and 8,680 participants from 2000 to 2019 showed that there is a strong negative correlation between mathematical anxiety and mathematics achievement. The same study emphasized that this relationship is especially more pronounced in tasks assessing problem-solving skills. Therefore, mathematical anxiety becomes a more serious barrier for students in tasks that require analysis, planning, and multi-step thinking than in tasks involving only the recall of arithmetic facts.

2. The Psychological Mechanism of Mathematical Anxiety

Working memory plays a central role in the process of solving mathematical problems. A student understands the conditions of the problem, identifies the given information, plans the sequence of operations, retains intermediate results, and continuously checks them. If anxious thoughts interfere in this process, a certain part of working memory is spent not on solving the problem itself, but on inner anxious reflections such as: “What if I make a mistake?”, “I will not be able to do this,” or “Others are better than me.”

From this point of view, it is more accurate to evaluate mathematical anxiety not merely as “fear,” but as a cognitive-psychological factor that reduces the efficiency of thinking. In particular, the effect of anxiety may be more strongly manifested in algebraic problems, tasks requiring logical consistency, multi-step proofs in geometry, and word problems. This is because such tasks require a high level of attention and working memory.

The emergence of mathematical anxiety is not linked to a single factor. The literature shows that its formation may be influenced by a student’s previous unsuccessful experiences, family relationships, stereotypes in society, the teacher’s style, and the classroom environment. For example, poor performance in mathematics may intensify mathematical anxiety, while anxiety may further reduce subsequent performance. In this way, a vicious cycle of “difficulty, anxiety, and even poorer results” is formed.

Family factors are also significant. A study devoted to the intergenerational approach found a negative relationship between the arithmetic performance of 6th-grade students and their mathematical anxiety. It also showed that children’s mathematical anxiety is associated with their mothers’ mathematical anxiety and the educational level of their parents. This result indicates that attitudes toward mathematics and the emotional background connected with it are also shaped through the family environment.

To clarify the psychological analysis, let us consider the following problem: the perimeter of a rectangle is 36 cm, and its length is 4 cm greater than its width. Find the area of the rectangle. Although this problem may appear, outwardly, to be a simple arithmetic-algebraic task, a number of the student’s cognitive processes and emotional states are actively involved in solving it. From this point of view, it is appropriate to evaluate problem solving not merely as a sequence of mathematical operations, but as a system of cognitive and psychological mechanisms.

First of all, while reading the problem text, the student attempts to understand its meaning. At this stage, the process involves perceiving verbal information, identifying the essential conditions, and transferring them into an internal mental plan. In particular, correctly understanding mathematical concepts such as “perimeter,” “length,” “width,” and “area”

determines the student's subsequent direction of thinking. If these concepts are not sufficiently well formed, the student may experience an initial state of uncertainty and hesitation. This, in turn, may increase psychological tension even before beginning to solve the problem.

At the second stage, the student imagines the situation described in the problem. Mentally visualizing the shape of the rectangle, understanding the relationship between its sides, and transforming the statement "its length is 4 cm greater than its width" into a mathematical relation require the interconnected functioning of visual-imaginative and logical thinking. At this point, students with better developed spatial imagination may understand the content of the problem more quickly, whereas students with weaker visualization abilities may struggle to grasp the relationship between the sides. Therefore, transforming a geometric image into an internal mental model is an important psychological stage in the problem-solving process.

At the next stage, the student denotes the unknown quantity: the width is expressed as x, and the length as $x + 4$. This process requires moving from verbal information to an abstract mathematical expression. It is precisely this point that is considered one of the most difficult stages for many students. This is because the student must not only understand the condition, but also translate it into symbolic language. From a psychological perspective, this stage relies on abstract thinking, generalization, and the ability to work with symbolic representations. If the student lacks sufficient confidence in their own abilities, they may stop at this point or make an incorrect designation.

In addition, the process of solving the problem is closely connected with the functioning of working memory. At the same time, the student must keep in mind that the perimeter is 36 cm, that the difference between the sides is 4 cm, that the perimeter formula must be used, and that the area must later be found. In such a multi-step thinking process, the load on working memory increases. If the student experiences strong mathematical anxiety, their attention is spent not only on the problem itself but also on internal anxious thoughts such as "Can I do this?" or "What if I make a mistake?" As a result, the efficiency of cognitive resources decreases, and errors may occur even in applying a simple formula.

The emergence of possible errors in this problem can also be explained psychologically. For example, some students may misinterpret the relation "the length is 4 cm greater than the width" and write $x - 4$ instead of $x + 4$. Others may confuse the perimeter formula with the area formula, or after finding the value of x, may forget to calculate the area, which is the main requirement of the problem. These situations reflect not only a lack of knowledge, but also distractibility, weak self-monitoring skills, and emotional pressure within the thinking process.

Thus, the analysis of this problem shows that the process of solving a mathematical problem is a multifaceted psychological phenomenon. It simultaneously involves such factors as attention, working memory, visual imagination, abstract thinking, logical analysis, self-monitoring, and emotional stability. Therefore, when evaluating a student's success in problem solving, it is necessary to pay attention not only to the final answer, but also to the student's thinking process, emotional state, and cognitive activity. This further strengthens the importance of a psychological approach in mathematics education.

Conclusion

In conclusion, mathematical anxiety is an important psychological factor that directly and indirectly affects the process of solving mathematical problems. It weakens a student's attention, working memory, self-confidence, and strategic thinking, and as a result, performance decreases, especially in complex and multi-step problems. Modern studies confirm that there is a stable negative relationship between mathematical anxiety and mathematics achievement, while working memory plays an important mediating role in this relationship. At the same time, teacher support, a positive learning environment, a growth mindset, family support, and properly

selected psychological interventions are considered effective factors in reducing mathematical anxiety. Therefore, in order to improve success in mathematics education, it is necessary to take into account not only content and methodology, but also the psychological state of the student.

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