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Mathematical Understanding in Problem Solving as Viewed through the Lens of Mathematics Anxiety among Elementary School Students

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Abstract: *This study aims to examine students' mathematical understanding in solving mathematical problems viewed from their levels of mathematical anxiety. The research employed a qualitative descriptive approach and was conducted at MI Attaqwa 26 Bekasi with 33 fifth-grade (VA) students as research subjects. The instruments used in this study consisted of a mathematical anxiety questionnaire to categorize students' anxiety levels, a geometry problem-solving test to assess students' mathematical understanding, and semi-structured interviews to explore students' reasoning processes in depth. Data were collected through questionnaires, written tests, and interviews, and were analyzed using qualitative data analysis techniques, including data reduction, data presentation, and conclusion drawing. The results of the study indicate that students with high mathematical anxiety were still able to demonstrate good mathematical understanding, as they could correctly interpret mathematical concepts and symbols, connect mathematical concepts to construct meaningful knowledge, explain mathematical ideas in their own words, apply concepts to new problem situations, and draw conclusions as well as generalize mathematical principles to solve various types of geometry problems. These findings suggest that high mathematical anxiety does not necessarily impede students' mathematical understanding in problem-solving activities.*
Keywords*: mathematical understanding, problem solving, mathematics anxiety*

Abstrak: Penelitian ini bertujuan untuk mengkaji pemahaman matematis siswa dalam menyelesaikan masalah matematika ditinjau dari tingkat kecemasan matematika yang dimiliki siswa. Penelitian ini menggunakan pendekatan deskriptif kualitatif dan dilaksanakan di MI Attaqwa 26 Bekasi dengan subjek penelitian sebanyak 33 siswa kelas VA. Instrumen yang digunakan dalam penelitian ini meliputi angket kecemasan matematika untuk mengelompokkan tingkat kecemasan siswa, tes pemecahan masalah geometri untuk mengukur pemahaman matematis siswa, serta wawancara semi-terstruktur untuk menggali proses penalaran siswa secara mendalam. Pengumpulan data dilakukan melalui angket, tes tertulis, dan wawancara, kemudian dianalisis menggunakan teknik analisis data kualitatif yang meliputi reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa siswa dengan kecemasan matematika tinggi tetap mampu menunjukkan pemahaman matematis yang baik, yaitu mampu menginterpretasikan konsep dan simbol matematika secara tepat, mengaitkan konsep-konsep matematika untuk membangun pengetahuan yang bermakna, menjelaskan ide-ide matematika dengan bahasa sendiri, menerapkan konsep dalam situasi masalah yang baru, serta menarik kesimpulan dan melakukan generalisasi prinsip-prinsip matematika untuk menyelesaikan berbagai jenis soal geometri. Temuan ini menunjukkan bahwa kecemasan matematika yang tinggi tidak selalu menghambat pemahaman matematis siswa dalam kegiatan pemecahan masalah.
Kata kunci: pemahaman matematika, pemecahan masalah, kecemasan matematika

INTRODUCTION

The cognitive domain of mathematics is multidimensional, just like any other subject. Mathematical understanding is a general and vague term used when students understand a part of mathematics in terms of procedures or skills. Teachers often claim students don't understand mathematics if they make errors in carrying out procedures or miscalculations. However, mathematical understanding is not only about the ability to perform procedures (skills), but also encompasses concepts, reasoning, and their uses. This creates a lack of clarity between concepts and procedures.

Skemp (2020) classifies mathematical understanding into instrumental and relational understanding. Instrumental understanding is the ability to correctly use a formula or procedure without understanding the reasoning behind it. Meanwhile, relational understanding is the ability to understand why a formula or procedure is used and how it relates to other concepts. According to Skemp, mathematical understanding is not just about memorizing formulas; it also involves explaining the relationships between concepts (Yurniwati & Handayani, 2019) .

Mathematical understanding is crucial in learning mathematics, as a solid understanding enables students to solve problems and apply their learning to the real world. Conceptual understanding in mathematics is interconnected, so if students fail to grasp a concept, they will have difficulty progressing through the material. If students struggle to understand the material, they will also struggle to solve related problems (Rusmana & Isnaningrum, 2012) .

According to Polya (1957) , mathematical understanding is the ability to understand the meaning of a concept, principle, or procedure, and to use it to solve problems. A person is said to understand mathematics if they are able to apply their knowledge flexibly in various situations . Based on these definitions, it can be interpreted that mathematical understanding is not just the ability to remember or use formulas, but also involves the ability to explain reasons, find relationships between concepts, and transfer knowledge to new contexts in a logical and meaningful manner.

To measure the level of understanding, indicators are needed that describe students' abilities in understanding concepts, procedures, and relationships between mathematical ideas. Based on the differences in types of understanding according to Skemp are: 1). Grouping objects based on the need to create a concept, 2). Applying concepts algorithmically, 3). Providing examples of a concept, 4) Repeating concepts that have been learned, providing several mathematical concepts, developing the needs needed by sufficient needs for certain concepts (Jehadus, 2020)

Conventional learning methods that do not actively involve students are one of the causes of low mathematical understanding, in addition to being exacerbated by the presence of mathematical anxiety experienced by some students. Students who experience anxiety in learning are disturbed in terms of information processing so that their learning outcomes are not optimal. For anxiety that is still normal, it can be overcome with the help of teachers through providing motivation, while severe anxiety can cause serious problems that require guidance, attention and teacher identification so that students can learn well. (Evens, 2000) . In mathematics learning, *math anxiety* can occur when students dislike and have a negative view of mathematics, as well as the fear and anxiety experienced by students so that they are uncomfortable when learning or interacting with mathematics.

Several previous studies have shown that mathematics anxiety has a significant influence on students' cognitive performance, particularly in problem-solving and conceptual understanding. Students with high levels of anxiety tend to experience difficulties in focusing attention, recalling prior knowledge, and connecting mathematical

concepts, which are essential components of relational understanding. However, most previous studies tend to examine mathematics anxiety and mathematical understanding as separate variables or focus primarily on learning outcomes, rather than exploring in depth how different levels of anxiety relate to students' conceptual understanding processes. This indicates the existence of a research gap that needs to be addressed.

One emotional reaction that often occurs in students when facing exams, especially math, is discomfort, such as tension or fear. For some students, exams are even seen as a burden or a problem that causes stress. This psychological state of fear, anxiety, or tension when facing a challenging situation is known as anxiety.

Hembree (2010) explains that math anxiety is an unpleasant affective reaction to situations related to mathematics, which is manifested through fear, worry, and stress. In line with Hembree's opinion, Soehardjono explains that anxiety is a manifestation of various physiological symptoms, such as trembling, excessive sweating, nausea, headaches, frequent urination, and palpitations or a pounding heartbeat. These symptoms reflect the body's response to stress or situations that are perceived as threatening, including in academic contexts such as exams (Sagarduy, 2024) .

Anxiety can have a positive impact when its intensity remains mild, as it can be a driving force or motivation for individuals to achieve excellence. However, when anxiety occurs at high intensity, the impact is actually negative and can cause physical and psychological disorders. According to Peplau, there are four levels of anxiety that individuals can experience: 1) Mild anxiety, which is usually manageable and encourages increased alertness; 2) Moderate anxiety, which begins to interfere with concentration but still allows individuals to function well with guidance; 3) Severe anxiety, which causes significant disturbances in thinking and behavior; 4) Panic, the highest level of anxiety in which individuals lose control of themselves and their environment. (Sugiatno & et al., 2017) .

From a cognitive perspective, high levels of mathematics anxiety can interfere with students' working memory capacity, which is crucial for understanding mathematical concepts and linking new information with prior knowledge. As a result, students may rely more on instrumental understanding rather than relational understanding. This theoretical connection further strengthens the importance of examining mathematical understanding from the perspective of students' anxiety levels.

The indicators of mathematics anxiety that will be used in this study are formulated and presented in the following table 1:

Table 1. Indicators of Mathematics Anxiety

No.	Aspect	Indicator
1.	Emotion	Feeling scared, anxious, restless, frustrated, tense, and uncomfortable.
2.	Cognitive	Loss of thinking ability and forgetting the material that has been taught.
3.	Somatic	Sweating, rapid breathing, dizziness, nausea, and trembling.
4.	Attitude	Avoiding anything that touches on mathematics, postponing math assignments, and refusing to do math assignments.

Math anxiety is a negative emotional state characterized by feelings of fear, tension, and discomfort when faced with math-related activities. According to Trujillo and Hadfield and Jackson and Leffingwell (Arem, 2010) , various factors contribute to math anxiety in students, including 1) Embarrassing experience, 2) Negative life experiences related to learning mathematics, 3) Social pressure and environmental expectations, 4) The desire for perfection, 5) Poor teaching methods, 6) Negative statements and thoughts about mathematics, 7) Cultural myths about mathematics, 8) Gender stereotypes and socialization.

Geometry material for fifth grade students contains the properties of geometric shapes, area and perimeter of geometric shapes and introduction to geometric shapes and their volumes. Based on interviews conducted by researchers with teachers: first, students are able to work on routine problems given by teachers, students have difficulty when given non-routine problems in the form of story problems, students have difficulty determining and solving problems correctly. Second, there is a lack of understanding of the core concepts of mathematics needed to solve problems, because of a wrong understanding of the concept, the results of solving the problem are also less precise. Third, there is a negative paradigm towards mathematics, they consider mathematics to be a difficult subject, so the material they have learned cannot be connected when they solve problems. This can be seen from the results of the initial assessment of mathematical understanding.

Figure 1. Initial Assessment of Mathematical Understanding

Students' ability to understand mathematical concepts varied across four key indicators. Of the 67 students, 35% were able to use procedural steps to solve mathematical problems, and 32% were able to group objects based on certain characteristics, indicating a basic understanding of conceptual grouping. Meanwhile, only 17% of students were able to provide examples of a concept, that is, apply the concept in a new concept, and 16% of students demonstrated the ability to repeat concepts that had been learned, that is, resolve errors and correct them based on the correct concept.

Based on previous studies, mathematics anxiety has been widely recognized as a factor that negatively affects students' learning outcomes. However, limited research has specifically examined how students' levels of anxiety relate to their conceptual

understanding in geometry learning at the elementary school level. Therefore, this study aims to fill this research gap by analyzing students' mathematical understanding in geometry from the perspective of their mathematics anxiety.

Based on the description above, the researcher wants to analyze the extent of students' understanding in learning geometry material viewed from student anxiety. Therefore, the title of this research is Mathematical Understanding in Problem Solving as Viewed through the Lens of Mathematics Anxiety among Elementary School Students"

METHODS

This study aims to analyze students' understanding of geometry concepts in solving problems viewed from the perspective of their mathematical anxiety. The researcher seeks to describe in depth how students with different levels of mathematical anxiety demonstrate conceptual understanding when solving geometry problems. This study employed a qualitative descriptive research design, as the data collected were descriptive in nature, consisting of written and oral information obtained from facts found in the field during the research process. The qualitative approach was chosen to allow a deeper exploration of students' reasoning processes, conceptual understanding, and experiences related to mathematical anxiety rather than to test hypotheses statistically.

The data sources in this study consisted of students' responses to a mathematical anxiety questionnaire, the results of a geometry conceptual understanding test, and semi-structured interview data. Data analysis was carried out using qualitative data analysis techniques, which included data reduction, data display, and conclusion drawing. Data reduction involved selecting and focusing relevant data related to students' mathematical understanding and anxiety levels. Data display was conducted by organizing the results of tests and interviews into meaningful categories, while conclusion drawing was carried out by interpreting patterns and relationships between students' levels of mathematical anxiety and their conceptual understanding of geometry.

The subjects of this study were fifth-grade students at MI Attaqwa 26 Bekasi. The selection of research subjects was conducted using purposive sampling, followed by stratified sampling. Purposive sampling was used to determine the class that was considered appropriate for the research objectives, namely a fifth-grade class that had received geometry instruction and showed varying levels of learning achievement. According to Sugiyono (2013), purposive sampling is a sampling technique based on certain considerations relevant to the research objectives. After the class was determined, stratified sampling was applied to group students based on their levels of mathematical anxiety. Stratified sampling is a sampling technique that divides the population into homogeneous subgroups or strata. The total number of students involved was 33, which represented the entire population of the selected class, allowing the researcher to capture a comprehensive overview of students' anxiety levels and conceptual understanding.

In this study, students were first given a mathematics anxiety questionnaire to identify and classify them into three categories: high, medium, and low mathematical anxiety. Based on these classifications, six students were selected as research subjects to

represent each anxiety category proportionally. These selected students were then given a geometry conceptual understanding test designed to assess their ability to interpret concepts, apply procedures, connect mathematical ideas, and solve both routine and non-routine problems. Following the test, semi-structured interviews were conducted to explore students' thought processes, reasoning strategies, and emotional responses when solving geometry problems.

The instruments used in this study consisted of a mathematics anxiety questionnaire, a geometry conceptual understanding test, and an interview guide. The mathematics anxiety questionnaire was adapted from established indicators of mathematics anxiety, including emotional, cognitive, somatic, and behavioral aspects, and was reviewed by experts to ensure content validity. The geometry test was developed based on indicators of conceptual understanding and aligned with the fifth-grade geometry curriculum. Instrument validity was ensured through expert judgment, while reliability was supported by consistency in scoring procedures and repeated data collection through time triangulation. Time triangulation was employed to enhance the credibility of the findings by collecting data at different times to ensure consistency in students' responses. The research process concluded with data interpretation and the preparation of a comprehensive research report.

RESULTS AND DISCUSSION

In this study, the selection of subjects was categorized into subjects with high, medium and low interest using categories, as shown in Table 2 below:

Table 2. Criteria for Grouping Mathematics Anxiety

Grouping Criteria	Category
Value ≥ mean + SD	Tall
Mean – SD ≤ value < mean + SD	Currently
Value < mean - SD	Low

Researchers grouped subjects after calculating the scores obtained from the mathematics anxiety questionnaire test. The following is Table 3, the results of the subject grouping based on the students' mathematics anxiety questionnaire, including the following:

Table 3. Criteria for Grouping Mathematics Anxiety

No.	Student Name	Math Anxiety Categories
1	ADR	Tall
2	ABS	Tall
3	AFY	Tall
4	AHA	Tall
5	ARR	Tall
6	ARM	Tall
7	AMH	Tall
8	AAN	Tall

9	BRN	Tall
10	BYH	Tall
11	DAT	Tall
12	FAH	Currently
13	NHN	Currently
14	HKP	Currently
15	IZN	Currently
16	ZN	Currently
17	KHD	Currently
18	KRN	Currently
19	MP	Currently
20	MAH	Currently
21	MHM	Currently
22	MIN	Currently
23	MNP	Currently
24	MHW	Currently
25	MPA	Currently
26	NSL	Low
27	RUD	Low
28	Hospital	Low
29	SAN	Low
30	Indonesian National Armed Forces	Low
31	TF	Low
32	ZAK	Low
33	ZAM	Low

Based on Table 3, the grouping above was obtained from the results of the mathematics anxiety questionnaire. In this study, the researcher selected six research subjects, consisting of two students from the low mathematics anxiety group, two students from the moderate mathematics anxiety group, and two students from the high mathematics anxiety group. Students from the low mathematics anxiety group with the highest score were labeled KMR1, while those with the lowest score were labeled KMR2. Students from the moderate mathematics anxiety group were labeled KMS1 and KMS2, and students from the high mathematics anxiety group were labeled KMT1 and KMT2.

The research data used in this study consisted of written test results and interview transcripts related to the subjects' problem-solving processes. Subject KMR1 demonstrated good conceptual understanding in solving problems, which was evident from the subject's ability to restate concepts clearly, classify them according to their properties, apply concepts algorithmically, and present them in correct mathematical representations. The subject was also able to connect various concepts systematically, enabling successful problem solving. Subject KMR2 showed conceptual understanding by restating and classifying concepts clearly and representing them mathematically, although the application of algorithmic concepts was not fully optimal. Nevertheless, the subject was still able to solve the given problem.

Subject KMS1 demonstrated conceptual understanding by restating known concepts using a Venn diagram; however, the planning and implementation of the chosen problem-solving strategy were less precise, indicating that algorithmic understanding was not yet fully developed. Similarly, subject KMS2 restated known concepts by writing given information but showed weaknesses in planning and implementing appropriate strategies, suggesting limited algorithmic conceptual understanding. Subject KMT1 was only able to restate known concepts by rewriting the problem statement and relied on simple operations without a clear strategy, indicating insufficient algorithmic understanding. Subject KMT2 was able to restate known concepts but failed to apply them algorithmically or represent them mathematically, resulting in an inability to solve the problem correctly.

Based on these findings, a clear pattern emerges showing that students with lower mathematics anxiety tend to demonstrate stronger conceptual understanding and more effective problem-solving strategies compared to students with moderate and high anxiety. This supports the theoretical perspective that mathematics anxiety negatively affects students' cognitive processes, particularly working memory and conceptual processing (Ashcraft & Krause, 2007). When students experience high anxiety, cognitive resources that should be used to understand concepts and plan strategies are instead consumed by worry and fear, leading to superficial or procedural problem-solving approaches.

The superior performance of students with low mathematics anxiety can be explained by their ability to engage in relational understanding, as proposed by Skemp. Low-anxiety students are more capable of connecting concepts, explaining relationships between ideas, and applying knowledge flexibly in new situations. This finding aligns with previous research by Hembree (2010) and Ramirez et al. (2018), which found that lower levels of mathematics anxiety are associated with better conceptual understanding and problem-solving performance.

In contrast, students with high mathematics anxiety tend to rely on instrumental understanding, focusing on memorized procedures without fully understanding underlying concepts. This explains why subjects KMT1 and KMT2 were only able to restate information without successfully implementing appropriate strategies. Similar findings were reported by Carey et al. (2016), who emphasized that high anxiety limits students' ability to integrate conceptual knowledge during problem solving.

In addition to mathematics anxiety, other factors may also influence students' mathematical understanding. These include students' learning styles, prior knowledge, and socioeconomic background. Students with supportive learning environments and access to learning resources may develop better conceptual understanding regardless of anxiety levels. Furthermore, differences in instructional methods, such as the use of contextual or student-centered learning approaches, can also affect how well students understand geometry concepts (OECD, 2019). Therefore, mathematics anxiety should be viewed as one of several interacting factors influencing students' conceptual understanding rather than the sole determinant.

Based on the overall findings, it can be concluded that mathematics anxiety plays a significant role in students' mathematical understanding in solving geometry problems. Students with low mathematics anxiety show better conceptual understanding, are able to explain and connect concepts, and implement problem-solving strategies coherently. This is consistent with the findings of Nikmah, Nur Sholekhatun, and Masduki (2016), who stated that students with low anxiety and strong conceptual understanding are able to explain concepts, identify relationships between concepts, prioritize conceptual applications, and demonstrate confidence in their mathematical reasoning.

CONCLUSION

Based on the findings and discussion, it can be concluded that students with low mathematical anxiety demonstrate a strong understanding of mathematical concepts in problem solving. These students are able to restate known concepts and classify them according to their properties accurately, apply concepts algorithmically, and present solutions using appropriate mathematical representations. In addition, they are able to connect various relevant concepts coherently, enabling them to solve problems correctly and systematically. This indicates that low levels of mathematical anxiety allow students to engage in deeper conceptual processing and to apply relational understanding when solving mathematical problems.

Students with moderate mathematical anxiety show partial conceptual understanding in problem solving. Although they are able to restate known concepts and classify them based on certain characteristics, they experience difficulties in applying concepts algorithmically. These students tend to rely on memorized strategies without fully understanding the underlying concepts or linking them to previously learned knowledge. As a result, their problem-solving processes are less systematic and their solutions are often incomplete or inaccurate.

Meanwhile, students with high mathematical anxiety exhibit limited conceptual understanding in solving problems. These students generally only restate the information given in the problem without being able to plan or implement appropriate problem-solving strategies. High levels of anxiety cause confusion and hesitation, which interfere with students' ability to connect concepts and apply them algorithmically. Consequently, students with high mathematical anxiety are often unable to complete the problem-solving process successfully.

From a practical perspective, these findings highlight the importance of addressing mathematical anxiety as part of everyday classroom practice. Teachers need to create a supportive and non-threatening learning environment that reduces students' fear of making mistakes and encourages active participation. The use of student-centered learning approaches, such as problem-based learning, collaborative group work, and contextual learning, can help students build conceptual understanding while gradually reducing anxiety. Providing positive feedback, emphasizing the learning process rather than solely correct answers, and allowing sufficient time for students to think can also help alleviate mathematics anxiety.

Based on the conclusions and limitations of this study, several suggestions can be proposed. First, teachers should actively identify students who experience moderate to high levels of mathematical anxiety and implement instructional strategies aimed at reducing anxiety, such as the use of concrete teaching aids, step-by-step guidance, and supportive questioning techniques. Second, students with moderate and high mathematical anxiety are encouraged to increase their learning interest and confidence by engaging in regular practice, reading mathematics-related materials, and seeking help when experiencing difficulties. Third, schools may consider providing teacher training programs focused on recognizing and managing mathematics anxiety in the classroom. Finally, future researchers are encouraged to further investigate students' conceptual understanding in problem solving by considering other influencing factors, such as learning styles, socioeconomic background, instructional methods, and students' prior mathematical knowledge, in order to obtain a more comprehensive understanding of the factors affecting mathematical learning.

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