

Research Article

Profile of Quality of Comprehension and Mathematics Anxiety of Grade IX Students of MTs Negeri Karangasem on Building Materials for Curved Side Spaces

Rahmiyati Maulida^{1*}, Djamilah Bondan Widjajanti²

¹ Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Indonesia; e-mail: rahmiyatimaulida.2022@student.uny.ac.id

² Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Indonesia; e-mail: djamilah_bw@uny.ac.id

*Corresponding Author: e-mail: rahmiyatimaulida.2022@student.uny.ac.id

Abstract: This study aims to: (1) describe the quality of mathematical understanding of Grade IX students at MTs Negeri Karangasem on the topic of curved surface solids, (2) identify the level of mathematics anxiety, and (3) examine the relationship between mathematical understanding and mathematics anxiety. This research employed a quantitative approach involving 100 students selected from 130 Grade IX students. Mathematical understanding data were collected using a three-item test based on indicators of instrumental, relational, and logical understanding, while mathematics anxiety data were obtained through a 30-item questionnaire. All instruments were validated by experts and showed adequate reliability based on Cronbach's Alpha. Data were analyzed using descriptive statistics, while the relationship between variables was tested using the Chi-Square test and the Fisher Freeman Halton Exact Test. The results show that most students (80%) have not yet achieved adequate mathematical understanding, while 20% demonstrate instrumental understanding. In terms of anxiety, 84% of students experience moderate anxiety, 11% high anxiety, and 5% low anxiety. Most students (67%) fall into the category of moderate anxiety with low understanding. Statistical results indicate that mathematical understanding and mathematics anxiety are significantly related.

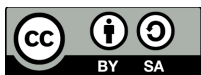
Keywords: Grade IX Students; Mathematical Understanding; Mathematics Anxiety; Quantitative Research; Relationship Analysis.

1. Introduction

Mathematics is a subject taught from elementary to secondary education, and has even been introduced since preschool through simple activities such as recognizing numbers and counting objects. The existence of mathematics in the curriculum is mandatory because it has an important role in shaping logical, analytical, systematic, critical, and creative thinking skills (Maulyda, 2019). In addition, the competency standards for graduates also emphasize the importance of literacy and numeracy as provisions for continuing education (Government Regulation of the Republic of Indonesia Number 4 of 2022). In line with this, *the Principles and Standards for School Mathematics* from NCTM (2000) mentions five main skills in mathematics learning, namely *problem solving, reasoning and proof, communication, connection, and representation*, all of which are important for students to master in facing various life problems.

The main goal of learning mathematics is for students to be able to understand concepts and the relationships between concepts, and to be able to apply them flexibly, accurately, and efficiently in problem solving. Understanding concepts is not only limited to memorizing formulas, but includes the ability to understand meaning, reason, and relate concepts to other situations (Yang et al., 2021). This is in line with the view that mathematics is hierarchical, so a strong mastery of basic concepts determines success in understanding more complex concepts (Arem, 2010). In this case, Skemp (1987) classified mathematical

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comprehension into three categories, namely instrumental, relational, and logical comprehension, which indicates the level of depth of student comprehension.

Despite having a very important role, students' mathematical skills in Indonesia are still relatively low. This can be seen from the results of *the Trends in International Mathematics and Science Study (TIMSS)* which shows that Indonesia is ranked 45th out of 50 countries with a score of 397 (Ministry of Education and Culture, 2018). In addition, the results of *the Programme for International Student Assessment (PISA)* also show unsatisfactory achievements, where in 2018 Indonesia was ranked 73rd with a score of 379, and decreased in 2022 to a score of 366 (OECD). Most students have not even reached the minimum level of competence in mathematics, which indicates difficulties in solving nonroutine problems and understanding concepts in depth.

This condition is also reflected in the national evaluation through the Computer-Based National Assessment (ANBK), which shows that students' numeracy skills are still in the medium category and vary between regions. At MTsN Karangasem, numeracy achievement is in the medium category with a growth score of 57.96%. In addition, the results of the Year-End Assessment (PAT) show that more than 90% of students have not achieved completeness with an average score of 59.57, far below the KKM set at 75. This data shows that students' mathematics learning achievement is still low, especially in the material Building Curved Side Spaces which is considered difficult by students, even though the material is close to daily life.

The low achievement of mathematics learning is inseparable from the low understanding of students' concepts. Several studies show a significant relationship between concept understanding and mathematics learning outcomes (Novitasari & Leonardo, 2017). A good understanding of concepts allows students to develop their mathematical skills optimally. However, in the learning process there are various obstacles, one of which is mathematical anxiety. This anxiety arises due to the perception that mathematics is a difficult, abstract, and confusing subject (Syafri, 2017). In addition, the assumption that mathematics is a benchmark of intelligence also adds pressure for students (Kusmaryono et al., 2020).

Math anxiety has a complex influence on learning outcomes. To a certain extent, anxiety can motivate students to study harder (Pratiwi, 2021). However, if it is excessive, anxiety actually has a negative impact on learning outcomes, as shown in research by Artama et al. (2020) which found a negative relationship between anxiety and mathematics learning outcomes. In addition, Diana et al.'s (2020) research showed that students with low levels of anxiety had better conceptual understanding abilities compared to students with moderate and high anxiety. This shows that there is a close relationship between cognitive and affective aspects in mathematics learning.

Based on these various descriptions, it can be concluded that understanding of mathematical concepts and anxiety are two important factors that affect the success of learning mathematics. However, previous research generally only focused on the level of understanding of concepts without examining their quality in depth based on the categories of instrumental, relational, and logical understanding. Therefore, this study is focused on analyzing the quality of mathematical comprehension and the level of mathematics anxiety of grade IX students of MTsN Karangasem in the material Building Curved Side Space. This research is expected to provide a more comprehensive picture and become a basis for teachers in designing more effective learning strategies to improve the quality of mathematics learning.

2. Literature Review

This theoretical study explains that learning is a physical and psychological activity that results in changes in behavior, knowledge, skills, and attitudes through experience, practice, and continuous reinforcement (Sutianah, 2022). Learning itself is a process of interaction between students, educators, and learning resources in a certain environment that is systematically designed so that goals are effectively achieved (Nurlina, et al., 2021). In the context of mathematics, learning aims not only to understand concepts, but also to apply them in real life and develop reasoning, problem-solving, communication, and mathematical attitudes (BSKAP, 2022). Mathematics as an abstract science has characteristics such as the use of symbols, deductive mindsets, and consistency (Simangunsong, 2022), and its learning

is influenced by internal and external factors, including psychological and environmental aspects (Sukmadinata in Syam, et al., 2022).

Mathematical comprehension includes "knowing what", "knowing how", and "knowing why" (Yoong, 1987), and according to Bloom (1956) is the ability to understand after knowing and remembering. Skemp (1987) divides understanding into three categories, namely instrumental understanding (the use of formulas without understanding reason), relational understanding (relating concepts and understanding reason), and logical/formal understanding (connecting symbols and ideas in logical reasoning). This understanding is related to procedural and conceptual knowledge Hiebert & Lefevre (1986), and is an indicator of the quality of student understanding through the ability to use symbols, relate concepts, and make logical decisions.

In addition, this study discusses Mathematics Anxiety, which is an emotional response in the form of fear, anxiety, and tension to mathematics (Richardson & Suinn, 1972). This anxiety can appear in physiological, cognitive, behavioral, and affective aspects Anindyarini & Supahar (2019), with symptoms such as negative thoughts, concentration disorders, and physical reactions (Arem, 2010). Although it can be motivating to some extent Mucholil (2018), in general, math anxiety has a negative impact on learning performance (Buckley, 2016).

In the material Building a Curved Side Space (BRSL), students are required to understand the concept of surface area and volume and solve contextual problems according to the curriculum (Permendikbud No. 37 of 2018). Various studies show that students' mathematical understanding is still dominated by the instrumental level, while relational understanding is higher in students with good abilities (Sari et al., 2022). Other research has also found a link between math anxiety levels and concept comprehension ability, where students with low anxiety tend to have better comprehension (Diana, et al., 2020).

Based on this description, it can be concluded that learning mathematics requires a deep understanding to a logical level, but is still influenced by psychological factors such as Mathematics Anxiety. Therefore, it is important to conduct research to analyze the relationship between the quality of mathematical understanding (instrumental, relational, logical) and the level of mathematical anxiety in students, especially in the material Building Curved Side Space.

3. Materials and Method

This type of research is a quantitative research based on the philosophy of positivism and is used to research a specific population or sample with statistical data analysis to test hypotheses (Sugiyono, 2013). In line with that, quantitative research is also understood as a method to test theories through relationships between variables using data in the form of statistically analyzed numbers (Creswell, 2013).

This approach is used because the research data is in the form of numbers obtained from the mathematics comprehension test and the Mathematics Anxiety questionnaire, which are then processed into categorical data. The research was carried out at MTsN Karangasem, Bali in March-May 2024, with a population of 130 students in grade IX and a sample of 100 students.

The data used are primary data, namely the results of the mathematics comprehension test on the Build a Curved Side Space material and a mathematical anxiety questionnaire. The research variables consisted of the quality of mathematical comprehension and the level of mathematical anxiety (Mathematics Anxiety), which were analyzed to find out the relationship between the two. The data collection technique used tests and non-tests, with instruments in the form of description questions (3 items) that measured instrumental, relational, and logical understanding, as well as a Likert scale questionnaire with 30 statements. The instrument is validated through expert judgment with content validity based on the suitability of the indicators, and is declared feasible after revision. Reliability was tested using Alpha Cronbach with a coefficient of 0.543 (medium category) for the comprehension test and 0.852 (high category) for the anxiety questionnaire.

Data analysis was carried out by grouping mathematical anxiety into high, medium, and low categories based on certain intervals (Djemari, 2008), and categorizing mathematical comprehension into instrumental, relational, and logical comprehension based on score

percentage. The relationship between the two variables was analyzed using the Chi-Square Test for Independence freedom test, with the hypothesis that the two variables are independent of each other or not independent of each other (Sholeh, 2018).

4. Results and Discussion

Research Results

The data from the study included the quality of students' mathematical understanding obtained through comprehension tests, as well as the level of Mathematics Anxiety measured using questionnaires. In addition, the relationship between the two variables was also analyzed through a contingency table.

Description of Students' Mathematics Comprehension Quality Data

Based on the results of the test on 100 grade IX students of MTsN Karangasem on the material Building the Curved Side Room, it was obtained that 80 students were in the category of not understanding because they did not reach the minimum limit of 60% on the instrumental comprehension indicator (score < 41 out of a maximum of 69). Meanwhile, 20 students were included in the instrumental comprehension category because they met the minimum score on instrumental indicators, but had not reached 60% on the relational comprehension indicator (score < 18 out of a maximum of 30). There are no students who fall into the category of relational or logical understanding. In general, the score achievement showed that the highest score in instrumental indicators reached 61 (88%), while in relational indicators only reached 17 (57%). The average score of each indicator was 22.40 (instrumental), 5.42 (relational), and 1.29 (logical), which indicated the low ability of students, especially in high level of understanding.

In the instrumental comprehension indicator, students still make many mistakes in writing formulas, such as exchanging the surface area formula for volume or not adjusting the formula to the combined shape. In the indicator mentioning the type of building, students are relatively able to recognize the building of the space well. However, in the calculation indicator, there are still many errors in the use of formulas, value substitution, and determination of final results. In relational understanding, students are not yet able to relate concepts, for example in drawing a sketch of a building or connecting the concept of volume with the unit price. Even in non-routine questions, most students stop at basic calculations without proceeding to advanced analysis. In logical understanding, students' ability to prove statements and draw logical conclusions is still very low, although there are some students who are able to formulate solution steps sequentially.

Description of Students' Mathematics Anxiety Data

The results of the questionnaire on 100 students showed that the math anxiety score had an average of 74.64 with a standard deviation of 12.55. Based on the calculation of the range ($M_i \pm 1.5Sd_i$), the categories of high anxiety ($93 \leq X \leq 150$), moderate ($56 \leq X < 93$), and low ($30 \leq X < 56$) were obtained. Most of the students, 84 people, were in the moderate anxiety category, 11 students in the high category, and 5 students in the low category. The highest score obtained by students is 101 and the lowest is 35.

Judging from the anxiety aspect, the highest score was found in the emotional aspect, which reflects the fear of failure, fear of being wrong, and low self-confidence. The cognitive aspect is also quite high, especially in the indicator of "forgetting formulas" those students often experience even though the questions are similar to the examples. Meanwhile, physical aspects such as respiratory distress are relatively low, and behavioral aspects show that students generally do not avoid math lessons. Thus, the anxiety experienced by students is more dominant in nature (emotional and cognitive) than physical or behavioral.

Data Description of the Relationship between Quality of Comprehension and Mathematical Anxiety Level

The results of the relationship analysis showed that most of the students with the category of not understanding were at moderate to high levels of anxiety, especially 67 students were in a combination of not understanding and moderate anxiety. All students with high anxiety (11 students) are included in the category of not understanding. In contrast, students with instrumental understanding tend to be at moderate and low levels of anxiety. There are no students in the category of relational or logical understanding at all levels of

anxiety. This shows a tendency that the higher the level of math anxiety, the lower the quality of understanding that students have.

Hypothesis Test of the Relationship between Quality of Mathematical Comprehension and Mathematics Anxiety

Hypothesis testing using the Chi-Square test (χ^2) with the degree of freedom $df = 2$ yielded a calculated χ^2 value of 7.75, greater than the χ^2 table of 5.99 at the significance level of $\alpha = 0.05$, so H_0 was rejected. This shows that the two variables are not independent of each other. However, due to a violation of the test assumptions (50% of cells had an expected frequency of less than 5), the analysis was continued with the Fisher–Freeman–Halton Exact Test which yielded a p value of $\approx 0.0089 < 0.05$. This result corroborates the previous decision that H_0 was rejected. Thus, it can be concluded that the quality of mathematics understanding and the level of mathematics anxiety of students have a significant relationship and are not mutually exclusive in the material Building Curved Side Spaces in grade IX MTs Negeri Karangasem.

Profile of the Quality of Students' Mathematical Comprehension

Based on the results of the study, most students were in the category of not understanding (80%), while the rest were in instrumental understanding and no relational or logical understanding was found. This shows that students' abilities are still at the procedural stage, namely being able to solve problems based on memorized steps without understanding concepts in depth. This condition is in line with Skemp (1987) who stated that instrumental understanding focuses on the use of procedures without understanding basic concepts. Judging from the Revised Bloom Taxonomy, students' abilities are at the C1 (Remembering), C2 (Understanding), and C3 (Applying) or LOTS levels (Wilson, 2016), and have not yet reached HOTS (C4–C6). Low comprehension is influenced by the learning process that has not accustomed students to HOTS questions, teaching methods, and learning interests (Suendarti & Liberna, 2021). In addition, cognitive ability also affects relational understanding, where students with high abilities tend to meet relational indicators compared to low-ability students (Utomo, 2021). Therefore, improving understanding can be done through varied learning such as RME or a combination of TPS and PBL (Rahmi et al., 2021).

Profile of Students' Mathematics Anxiety Level

The results showed that the majority of students experienced moderate (84%) mathematics anxiety, followed by high (11%) and low (5%) levels, with a dominance of affective aspects. This finding is in line with Sopiatus et al. (2024) who stated that anxiety is in the moderate category with the most dominant affective aspect. Anxiety arises due to fear, lack of confidence, negative experiences, and environmental factors such as learning methods and parental influence (Tobias, 1993). The impact is not only on emotions, but also on the cognitive aspect because it interferes with working memory so as to hinder the thinking process (Ashcraft & Kirk, 2001). Efforts to overcome anxiety can be done through the application of a growth mindset (Huang, 2025), learning strategies as stated by Freedman (2012), and the use of varied and fun learning models (Prasetyo & Juandi, 2023). In addition, scaffolding given gradually is also effective in helping students understand concepts while reducing anxiety (Kusmaryono et al., 2020).

The Relationship between the Quality of Mathematical Comprehension and Students' Mathematics Anxiety

The results showed a relationship between the quality of mathematical comprehension and mathematical anxiety. Students with high anxiety were all in the category of not comprehensive, which suggests that anxiety has a negative effect on comprehension. This is in line with Živković et al. (2023) who stated that there is a negative correlation between math anxiety and math achievement. At a moderate level of anxiety, some students are still able to achieve instrumental understanding, so that anxiety at a moderate level can function as a motivator. However, in general, anxiety still inhibits cognitive processes through working memory disorders Ashcraft (2001) and lowers self-confidence (Lu'luilmaknun et al., 2020). This reciprocal relationship is also affirmed by Changhong et al. (2021) and Kamid et al. (2025), who show that high anxiety inhibits the achievement of cognitive equilibrium. Thus, low comprehension can trigger anxiety, and conversely anxiety worsens comprehension.

5. Conclusion

Based on the formulation of the problem, the data from the research results, and the discussion, it can be concluded that the mathematical understanding of grade IX MTsN Karangasem students in the material Building the Curved Side Space is dominated by the category of not understanding, with 80 out of 100 students in this category and 20 students in the instrumental understanding category, without any relational understanding and logical. This shows that students are able to solve routine problems according to algorithms, but are not able to connect concepts to solve non-routine problems and those that require logical reasoning. The majority of students' math anxiety levels were in the medium category, namely 84 students, followed by 11 students with high anxiety and 5 students with low anxiety, with the dominant aspects being felt successively including feelings, cognitive, behavioral, and physical, which indicated that there was no avoidance of mathematics learning. The results of the contingency table show that the dominance of students in the category of moderate and incomprehensible anxiety, and all students with math anxiety are in the category of not comprehensive. In moderate anxiety, a small percentage of students achieve instrumental comprehension, while in low anxiety there is a variation between incomprehension and instrumental comprehension. Statistical tests show that the quality of math comprehension and the level of math anxiety are not mutually exclusive.

Based on the results of the research by considering the existing limitations, it is suggested that teachers need to apply a varied learning model to stimulate students' thinking processes to better understand mathematical concepts, accompanied by providing examples and practice questions from easy levels to those that require higher understanding, so that students are used to solving problems that require instrumental understanding, the relationship between concepts, and logical reasoning. In addition, efforts to overcome mathematical anxiety need to be carried out through learning designs that pay attention to cognitive and affective aspects, the use of appropriate methods and media, and the provision of appropriate scaffolding. A conducive classroom atmosphere also needs to be built so that students feel safe, comfortable, and not afraid to make mistakes, accompanied by constructive feedback to encourage relational and logical understanding. Improving the quality of learning should consider the link between math comprehension and math anxiety by integrating strategies that foster confidence, reduce psychological distress, and create enjoyable learning. School support is also important through the provision of learning facilities, teacher training related to student psychology, and collaboration with counseling guidance teachers to help students with high anxiety, while building a learning culture that respects the process. Furthermore, follow-up research needs to be developed by improving the instrument design and in-depth interviews to strengthen and triangulate data related to relational thinking processes and causes of mathematical anxiety.

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