

Analysis of Numeracy Ability and Mathematical Anxiety of Junior High School Students

¹Maisaroh Tamrin, ²Al Jupri, ³Kusnandi

^{1,2,3}*Mathematics Education Study Program, Universitas Pendidikan Indonesia*

¹maisarohtamrin03@gmail.com

Abstract

Numeracy refers to an individual's ability to apply mathematical knowledge in everyday life to solve problems, analyse situations, and evaluate the results of their solutions. This study aims to assess the level of numeracy, mathematical anxiety, and the relationship between these two factors among grade IX junior high school students. The methodology employed is a case study with a qualitative approach. The subjects include 32 grade IX students from a junior high school in Bandung who have studied the topic of flat-sided solid figures. Data collection involved test techniques for numeracy assessments and non-test methods, including mathematical anxiety questionnaires and interview guidelines. The findings indicate that most students' numeracy abilities fall within the moderate range and that they experience moderate levels of mathematical anxiety. Students with low levels of mathematical anxiety demonstrated strong numeracy ability, as evidenced by meeting nearly all indicators of numeracy ability. Students exhibiting moderate mathematical anxiety displayed varying levels of numeracy, meeting 1 to 3 indicators of numeracy ability. In contrast, students with high levels of mathematical anxiety struggled with low numeracy ability, achieving only 1 or none of the numeracy indicators. These findings suggest the importance of integrating strategies that address both cognitive and emotional aspects of mathematics learning. Teachers are encouraged to design instructional approaches that reduce students' mathematical anxiety while simultaneously strengthening their numeracy ability.

Keywords: Numeracy Ability, Mathematical Anxiety, Geometry Flat Side.

Introduction

Mathematics plays a foundational role in developing logical reasoning, analytical thinking, and problem-solving skills that are essential for informed decision making in modern society. Beyond procedural competence, mathematics supports the development of structured thinking patterns necessary for navigating quantitative information in daily life and academic contexts. Therefore, mathematics serves as a core discipline that underpins cognitive development and quantitative literacy in contemporary education (Safitri & Dewi, 2017). In 2015, the World Economic Forum identified six foundational literacies that every student should master: reading and writing, numeracy, scientific, cultural and civic, financial, and digital. (Ate & Lede, 2022). One of these six literacies is numeracy. Numeracy is closely related to reasoning and problem-solving skills, which serve as a fundamental foundation for students learning across subjects.

According to Han et al. (2017), numeracy refers to the knowledge and ability to understand and use numbers and mathematical symbols to solve practical problems in various real-life contexts. Similarly, Yustinaningrum (2023) defines numeracy as an individual's ability to apply reasoning when analysing and interpreting information involving mathematical

representations. This reasoning process includes understanding statements, manipulating mathematical symbols, and interpreting quantitative information encountered in everyday situations.

The importance of numeracy ability can be seen in the mathematics learning process, such as using students reasoning power or critical patterns in solving problems faced (Salvia et al., 2022). No exception in the era that uses the current independent curriculum, students must strengthen their numeracy ability. A person who has good numeracy can solve problems and think critically about the problems they will face. (Salvia et al., 2022). This can result in a good mathematics learning process.

Students' numeracy ability in Indonesia is still considered relatively low when compared with national and international benchmarks. The Indonesian Ministry of Education, Culture, Research, and Technology has introduced the Assessment Competency Minimum as a national evaluation framework to measure students' literacy and numeracy competencies. In this framework, students are expected to demonstrate the ability to interpret mathematical information, apply mathematical concepts to real-life contexts, and solve reasoning-based problems. However, various studies have shown that many students still struggle to reach these expected competencies. For example, Susetyawati and Kintoko (2023) reported that only 28% of 32 junior high school students demonstrated good numeracy ability, while the remaining 72% had not yet mastered this competency.

Several previous studies have reported that students' numeracy ability is still relatively low. Mahmud and Pratiwi (2019) found that many junior high school students experience difficulties when solving unstructured mathematical problems because they are unable to interpret mathematical information and determine appropriate solution strategies. Similarly, Lamada et al. (2019) reported that students often struggle to connect mathematical concepts with contextual problems, which affects their ability to solve numeracy-based tasks. Furthermore, Mulyani et al. (2024) revealed that students' numeracy ability in solving arithmetic sequence problems was still categorised as low to moderate. These findings indicate that many students still encounter difficulties in interpreting problems, selecting appropriate strategies, and drawing correct mathematical conclusions.

Several factors contribute to the low level of literacy skills among students in Indonesia. One of the causes can be the existence of misconceptions among students in schools (Suparya et al., 2022). Misconceptions or misunderstandings in understanding concepts can be triggered by internal and external factors, such as students' negative views of mathematics. Many students consider mathematics as a difficult, scary, and unpleasant subject. This perception can affect students' psychology, creating a mental condition that is less supportive of optimal learning.

These negative psychological conditions often lead to anxiety. According to Susanto (2016), anxiety in the learning process has a significant impact on students' learning experience, where feelings of anxiety can encourage students to avoid situations that cause anxiety. Syafri (2017) stated that negative attitudes towards mathematics can arise when students experience difficulties in solving problems and this occurs repeatedly and causes students to feel worried. Mathematics is one of the subjects that often triggers anxiety among students. The anxiety that arises in mathematics lessons is commonly called mathematical anxiety.

Mathematical anxiety is a state in which a person experiences feelings of tension that affect the way they solve mathematical problems in academic and everyday contexts. Mathematical anxiety in students is still a significant problem in Indonesia (Nur et al., 2024). Mathematical anxiety refers to feelings of tension and worries that interfere with an individual's ability to engage with mathematical tasks (Richardson & Suinn, 1972). It affects not only students' emotional responses but also their cognitive processing and problem-solving performance (Cooke et al., 2011).

Mathematical representation skills are important in helping students understand and solve mathematical problems. Previous studies have shown that students with high mathematical anxiety often experience difficulties in constructing and interpreting mathematical representations, which can negatively affect their problem-solving performance and numeracy (Maysyaroh & Hidayati, 2024). Pratiwi (2021) also found that mathematical anxiety had a negative and significant impact on students' mathematical representation abilities, with an influence of 35.9%, which is quite significant. Therefore, examining the relationship between mathematical anxiety and students' mathematical representation skills is important for improving mathematics learning outcomes.

Mathematical anxiety often contributes to students' low academic performance in mathematics, which affects the process of numeracy ability. In this study, numeracy refers to students' ability to understand mathematical information, apply mathematical concepts to contextual problems, and interpret the results of mathematical solutions in everyday situations (Harefa et al., 2023). These abilities represent the numeracy process that students use when solving mathematical problems. Therefore, numeracy in this study is analysed through several indicators that reflect students' abilities to understand problems, apply mathematical strategies, and interpret mathematical results.

Table 1
Indicators of Numeracy Ability

Indicator	Description
Understanding mathematical information	Students are able to identify and understand relevant mathematical information presented in contextual problems.
Applying mathematical concepts	Students are able to select and apply appropriate mathematical concepts, procedures, or formulas to solve the problem.
Interpreting mathematical results	Students are able to interpret the results of calculations and relate them to the context of the problem to draw appropriate conclusions

These indicators were used as the basis for analysing students' numeracy abilities in solving the given problems. Each student's response was evaluated according to the extent to which these indicators were fulfilled.

Based on the results of previous research entitled "The Relationship between Mathematical Anxiety and Numeracy Ability on Student Learning Outcomes" by Harefa et al. (2023), the results showed that mathematical anxiety affects 70.2% of numeracy ability, and student learning outcomes are influenced by 93% of numeracy ability in high school students. This finding is in line with the opinion of Whyte and Anthony (2012) who stated that mathematical

anxiety can affect a person in various forms, both cognitive, affective, physical, and mathematical knowledge. Students who experience mathematical anxiety often have difficulty solving a problem, feel insecure and even experience physical symptoms such as heart palpitations and dizziness.

Although there have been many studies examining the relationship between mathematical anxiety and mathematics learning outcomes, there is still a lack of literature that specifically explores the relationship between mathematical anxiety in the context of numeracy ability, especially at the junior high school level. Previous research tends to focus on the impact of mathematical anxiety on academic outcomes in general, without considering aspects of numeracy that are linked to mathematical anxiety which is increasingly important in education today.

This study attempts to fill this gap by analysing the relationship between numeracy ability and mathematical anxiety in junior high school students, who are a critical age group in the formation of mathematical attitudes and abilities. By conducting research in locations that are indicated to have problems with low numeracy achievements, this study is expected to provide new and relevant insights. The novelty of this study lies in the approach that links numeracy and mathematical anxiety in a context that has not been widely studied, so that it can provide a significant contribution to the development of more effective learning strategies.

Methods

This study employed a qualitative case study design. According to Creswell (2009), a qualitative approach is a study useful for exploring and understanding the meaning that arises from a social problem. Rahardjo (2017), a case study is a series of scientific activities carried out comprehensively, in detail and in depth regarding an event or activity at the individual, group, institutional or organisational level with the aim of gaining a better understanding of the event being studied. This study was conducted at one of the Junior High Schools in Bandung City.

The participants were 32 ninth grade students who had completed the topic of flat sided solid geometry. Students were categorised into high, medium, and low groups based on their numeracy test scores and mathematical anxiety questionnaire results. Although numeracy scores were calculated and presented descriptively, the main analysis in this study was conducted qualitatively. The scores were used to categorise students into high, medium, and low groups to select representative subjects for further analysis. The qualitative analysis focused on examining students' problem-solving processes, the fulfilment of numeracy indicators, and the interview results to understand how mathematical anxiety influences students' numeracy abilities.

After the assessment, students' numeracy scores and mathematical anxiety questionnaire results are grouped based on the value intervals displayed in a table (Ma'sum, 2014). These categories can be seen in Table 2.

Table 2
Student Group Categorisation

Value (N)	Criteria
$N \geq (\mu + 1.0\sigma)$	High
$(\mu - 1.0\sigma) \leq N < (\mu + 1.0\sigma)$	Medium
$N < (\mu - 1.0\sigma)$	Low

The mathematical anxiety scale questionnaire was used in this study to assess the level of mathematical anxiety. This instrument has twenty statements, including half positive and half negative statements. To calculate the mathematical anxiety score, each person's score is summed based on a 4-point weighting category on a Likert scale (Hadi, 1991). The questionnaire was used to obtain mathematical anxiety data statements arranged based on mathematical anxiety indicators; (1) attitude, (2) somatic, (3) cognitive, and (4) mathematical knowledge.

The mathematical anxiety questionnaire data was processed using the successive interval method, which is the process of changing data that was originally on an ordinal scale into interval scale data which was carried out in the categorisation of the questionnaire data. The categorisation of student's mathematical anxiety levels refers to Tables 2.

Furthermore, the researcher used the interview guideline as a guide to conduct the interview. Informal semi-structured interviews were used in this study. This interview is included in the in-depth interview category. The interview subjects in this study were teachers and students. Students who were taken for the interview were students with levels of mathematical anxiety and numeracy ability that were in each category of high, medium, and low which were determined based on the scores obtained.

Results and Discussion

Numeracy Ability

The data of the findings of the students' tests who have completed the descriptive questions of numeracy ability are then analysed and grouped based on the established scoring guidelines. The results of the numeracy test were used as a basis to determine the extent of student's numeracy ability in answering the given questions. The data of the student's numeracy ability test results can be seen in Table 3.

Table 3
Numeracy Ability Data

N	Min	Max	Mean	Std. Deviation
32	10	90	66.69	20.57

The numeracy scores were obtained from students' responses to a set of descriptive test questions designed based on the indicators of numeracy ability. Each question was assessed using a scoring rubric that evaluated students' ability to understand the problem, apply appropriate mathematical concepts, and interpret the results of their solutions. The total score for each student represents the level of numeracy ability demonstrated in solving the given problems. Higher scores indicate better achievement of the numeracy indicators.

After obtaining the average and standard deviation, the students test result data were grouped into three categories: high, medium, and low. Table 4 shows the distribution of the categorisation of students' numeracy test results.

Table 4

Distribution of Students' Numeracy ability

Category	Score	Frequency	Percentage
High	$x \geq 87.26$	4	12.5%
Medium	$46.12 \leq x < 87.26$	24	75%
Low	$x < 46.12$	4	12.5%
Total		32	100%

Based on the distribution of students' numeracy ability grouping, most ninth-grade students at a junior high school in Bandung are in the medium group. Subjects in the high numeracy ability group can meet 2 to 3 indicators in 1 question, the moderate numeracy ability group can meet 1 to 2 indicators in 1 question, while the low numeracy ability group does not achieve any indicators in 1 question, with different scores for each subject. These results are supported by Mulyani et al. (2024), Mahmud & Pratiwi (2019), and Lamada et al. (2019) concluded that subjects in the low category could not fulfil the three indicators of numeracy ability. In contrast, subjects in the medium category could only fulfil the first and second indicators. Subjects in the high category fulfilled the three indicators of numeracy ability. Alifiah et al. (2020) and Sari & Aini (2022) also revealed that students with high numeracy test results could meet two to three indicators, while students with low numeracy test scores only met one or none.

Mathematics Anxiety

Data on mathematical anxiety were obtained from a mathematical anxiety questionnaire completed by students in an offline setting. The questionnaire consisted of 20 statements, including 10 positive and 10 negative items. Each statement provided four response options: SS (Strongly Agree), S (Agree), TS (Disagree), and STS (Strongly Disagree).

The student mathematical anxiety data can be seen in Table 5. Based on Table 5, with 32 students as subjects, the lowest score was 31, while the highest score reached 69. The average score of all students was 51.78, which shows a tendency for the score to be around that number. In addition, the standard deviation value of 7.96 indicates the level of variation or spread of data from the average value, which means that there is a significant difference between the values obtained by students.

Table 5

Students' Mathematical Anxiety Data

N	Min	Max	Mean	Std. Deviation
32	31	69	51.78	7.96

The mathematical anxiety score data obtained is then grouped into three categories: high, medium, and low. Table 6 shows the distribution of students' mathematical anxiety data categorisation.

Table 6
Students' Mathematical Anxiety Categories

Category	Score	Frequency	Percentage
High	$x \geq 59.74$	4	12.5%
Medium	$43.82 \leq x < 59.74$	26	81.25%
Low	$x < 43.82$	2	6.25%
Total		32	100%

The results of the analysis of the questionnaire and interviews showed that most of the ninth-grade students at junior high school in Bandung had a moderate level of mathematical anxiety, with a percentage of 81.25% or 26 out of 32 students. Students with high mathematical anxiety tend to experience quite a lot of pressure and fear when facing mathematics. They often feel uncomfortable and worried during learning, exams, or doing assignments. Some students admitted to feeling afraid of being wrong, nervous, and even forgetting the material studied previously during the math exam. This is in line with research conducted by Shishigu (2018) and Azizah (2020) which revealed that previous mathematical experience can influence students to show mathematical anxiety. Hakim et al. (2021) also stated that excessive mathematical anxiety can interfere with learning which can be seen from students not liking mathematics lessons, being afraid of mathematics lessons which impact students' cognitive abilities.

Students with low mathematical anxiety showed a more positive attitude and confidence in dealing with mathematics. They generally felt comfortable during mathematics learning, were able to stay calm when doing mathematics exams, and were able to do mathematics assignments well. Although sometimes there was a little anxiety when facing difficult problems, they were able to overcome this anxiety with effective learning strategies and support from their surroundings. Students' self-confidence and independence in doing mathematics assignments were also important factors that helped them maintain their mathematical anxiety levels in the low category.

The Relationship between Numerical and Mathematical Anxiety

Based on the results of the categorisation of students' numeracy abilities in terms of mathematical anxiety levels, it was obtained that there were no students who had a high numeracy ability category with high mathematical anxiety and students who had low numeracy abilities with low mathematical anxiety.

Based on Table 7, it can be concluded that the level of achievement of the numeracy ability indicators shows different variations in responses at each level of students' mathematical anxiety. The results showed that groups with low mathematical anxiety tended to achieve more numeracy ability indicators than groups with moderate or high anxiety. As a reference, the researcher set the success criteria if a mathematical anxiety group met at least 70% of the

numeracy ability indicators. This limit is used to evaluate the extent to which each group is able to meet the numeracy ability indicators.

Analysis of the relationship between numeracy and mathematical anxiety shows a fairly strong negative correlation. The pattern found from the test results and interviews shows that students with low anxiety tend to have high numeracy ability. They are calmer in understanding questions, can work sequentially, and can explain their reasons logically.

Table 7

Data on Achievement of Numeracy Ability Indicators Reviewed from Mathematical Anxiety.

Category Mathematical Anxiety	Subject	No Question	Indicators of Numeracy Ability		
			Indicator 1	Indicator 2	Indicator 3
Low	S22	1	✓	✓	✓
		2	✓	✓	✓
		3	✓	✓	✓
	S26	1	✓	✗	✓
		2	✓	✓	✓
		3	✓	✓	✓
	% Achievement		100%	85.71%	100%
	Indicator Achievement Description		Meets the numeracy indicators	Meets the numeracy indicators	Meets the numeracy indicators
	Medium	S5	1	✓	✓
2			✓	✓	✓
3			✓	✓	✓
S17		1	✓	✗	✗
		2	✓	✓	✗
		3	✓	✓	✓
S10		1	✗	✗	✗
		2	✗	✗	✓
		3	✗	✗	✓
% Achievement		66.67%	55.56%	66.67%%	
Indicator Achievement Description		Does not meet the numeracy indicators	Does not meet the numeracy indicators	Does not meet the numeracy indicators	
High	S2	1	✓	✗	✓
		2	✓	✗	✗
		3	✓	✓	✗
	S4	1	✗	✗	✗
		2	✗	✗	✗
		3	✗	✗	✗
	% Achievement		50%	16.67%	16.57%
	Indicator Achievement Description		Does not meet the numeracy indicators	Does not meet the numeracy indicators	Does not meet the numeracy indicators

In contrast, students with high anxiety show a tendency to have low numeracy achievement. They have difficulty understanding the context of flat-sided geometric problems, are confused about using the appropriate formula or procedure, and fail to formulate interpretations or

conclusions from flat-sided geometric problems. In fact, in some cases, students show a passive attitude and avoid working on the problems altogether.

The results also show differences in the achievement of numeracy indicators among students with different levels of mathematical anxiety. The second indicator refers to students' ability to apply appropriate mathematical concepts or procedures when solving contextual problems, while the third indicator refers to students' ability to interpret the results of their calculations and relate them to the context of the problem. Students with low mathematical anxiety were generally able to fulfil these indicators because they were more confident and able to focus on analysing the problem and applying suitable solution strategies. In contrast, students with high mathematical anxiety often experienced difficulties in applying mathematical procedures and interpreting results, which caused them to fail in meeting the second and third indicators. This finding is consistent with the distribution of numeracy ability presented in Table 4, where students with higher numeracy scores were more likely to fulfil multiple indicators of numeracy ability.

These results strengthen the theory of Whyte & Anthony (2012), Harefa et al. (2023), Utami & Fuadiah (2018), and Munasiah (2016) which states that mathematical anxiety can affect students' cognitive and affective aspects, which have an impact on their ability to solve mathematical problems. Anxiety disrupts the flow of logical thinking and reduces the effectiveness of decision making in solving contextual problems

Conclusion

The majority of students' numeracy abilities are in the medium category and have medium levels of mathematical anxiety. Students with low mathematical anxiety conditions have high and medium levels of numeracy ability, marked by the fulfilment of almost all indicators of numeracy ability. Students with medium mathematical anxiety conditions have varying levels of numeracy ability, namely high, medium, and low numeracy ability, which are marked by the fulfilment of 1 to 3 indicators of numeracy ability. Students with high mathematical anxiety conditions have moderate and low numeracy ability, which are marked by only achieving one or none of the indicators of numeracy. Future research may explore instructional strategies aimed at reducing mathematical anxiety while simultaneously strengthening numeracy ability. Investigating intervention-based approaches could provide deeper insights into how emotional and cognitive factors interact in mathematics learning.

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