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Analyzing Students' Numeracy Literacy in Relation to Mathematics Anxiety

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Effectiveness of the Multi-Representation Discourse Learning Model on Mathematical Problem-Solving Ability and Self-Confidence

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ABSTRACT

The growing global emphasis on numeracy as a core competency for 21st-century learners underscores the urgency of addressing mathematics anxiety, which may act as a critical barrier to students' achievement. This study aims to analyze seventh-grade students' numeracy literacy in relation to mathematics anxiety and to examine the association between three indicators of numeracy literacy and three levels of mathematics anxiety (low, moderate, and high). A qualitative approach was employed with six students purposively selected based on mathematics anxiety questionnaire results, consisting of two students from each anxiety level. The instruments included (1) a numeracy literacy test on two-dimensional geometry, (2) a mathematics anxiety questionnaire, and (3) a semi-structured interview protocol. Data were analyzed using Miles and Huberman's model with triangulation to ensure validity and trustworthiness. The findings indicate that students with low mathematics anxiety successfully demonstrated all numeracy literacy indicators. In the moderate-anxiety group, one student achieved all indicators while another met only one. Students with high anxiety failed to demonstrate any indicator, suggesting that heightened anxiety hindered their mathematical performance. Theoretically, this study contributes to the growing body of literature on the interplay between affective factors and numeracy literacy by providing empirical evidence from the context of junior secondary education. Practically, the findings offer insights for teachers and policymakers to design pedagogical interventions that reduce mathematics anxiety and enhance students' capacity for logical reasoning and problem-solving.

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Introduction

Numeracy literacy is broadly defined as an individual's ability to access, use, interpret, and communicate mathematical information in a variety of real-life contexts. As highlighted by

the Programme for International Student Assessment (PISA), which evaluates students' competencies in reading, mathematics, and science, Indonesian students continue to face substantial challenges. The 2022 PISA results revealed a decline in Indonesia's average mathematics score from 379 in 2018 to 366 in 2022. Alarmingly, only 18% of Indonesian students reached level 2 proficiency in mathematics, far below the international average, indicating that Indonesian students' numeracy literacy remains at a relatively low level. This is concerning, as numeracy literacy is considered an essential 21st-century skill, enabling students to think critically and logically in solving everyday problems (Apipatunnisa et al., 2022).

Numeracy literacy encompasses more than basic arithmetic; it includes the ability to analyze and interpret numerical data presented in diverse visual forms (such as tables, charts, and diagrams) in order to predict outcomes, draw conclusions, and make informed decisions. Scholars have described numeracy literacy as the ability to understand and process mathematical information through reading and writing (Widiastuti & Kurniasih, 2021), to reason with numbers and symbols in solving daily problems (Salsabilah & Kurniasih, 2022), and to apply mathematical concepts in logical reasoning (Ate & Lede, 2022). Thus, numeracy literacy is widely recognized as a fundamental competence that underpins students' mathematical problem-solving abilities and represents a minimum benchmark of educational achievement (Gulo et al., 2025).

However, students' development of numeracy literacy often encounters barriers, one of the most prominent being mathematics anxiety. Mathematics anxiety refers to negative emotional responses characterized by feelings of tension, nervousness, or even somatic symptoms when engaging in mathematical tasks (Juliyanti & Pujiastuti, 2020). While a moderate level of anxiety may motivate students to work harder, excessive anxiety can significantly hinder concentration, reasoning, and overall mathematical performance (Mulyani et al., 2025). Previous studies have confirmed that high levels of mathematics anxiety are significantly correlated with lower problem-solving performance and reduced academic achievement in mathematics (Setiani, 2016; Wardani, 2022).

Preliminary observations conducted with teachers in a junior secondary school in Makassar confirmed that many seventh-grade students struggle with solving contextual mathematics problems, particularly word problems related to real-life contexts. In addition, several students exhibited high levels of mathematics anxiety, especially when dealing with basic concepts such as number operations and fractions. These findings align with earlier research showing that excessive anxiety can disrupt students' focus, cause panic, and even lead them to avoid mathematics lessons altogether (Salvia et al., 2022).

Given this evidence, reducing mathematics anxiety is crucial to improving students' numeracy literacy. Nevertheless, few studies have explored in depth how mathematics anxiety interacts with different dimensions of numeracy literacy among Indonesian junior secondary students. Therefore, this study seeks to analyze seventh-grade students' numeracy literacy from the perspective of mathematics anxiety, focusing on the relationship between three indicators of numeracy literacy (data interpretation, reasoning, and problem solving) and three levels of mathematics anxiety (low, moderate, and high). This study aims to fill an important research gap by providing empirical evidence on the interplay between affective factors and cognitive competencies. Practically, the findings are expected to guide teachers, curriculum developers, and policymakers in designing targeted pedagogical interventions to reduce mathematics anxiety and enhance students' numeracy literacy, thereby supporting more equitable and effective mathematics learning in lower secondary education.

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Method

Settings

This study employed a qualitative case study design to provide an in-depth understanding of the phenomenon of numeracy literacy in relation to mathematics anxiety. The research was conducted at SMPS Babul Istiqamah, a private junior secondary school located in Makassar, South Sulawesi, Indonesia. The study took place during the second semester of the 2024/2025 academic year. The school was selected because preliminary classroom observations and discussions with the mathematics teacher indicated that students frequently experienced difficulties in numeracy literacy, particularly when dealing with contextual mathematics problems such as word problems. Among the seventh-grade classes, Class VII A was identified as having the most prominent challenges in this area, with several students showing signs of anxiety when engaging with mathematics tasks. This setting was therefore considered appropriate for investigating the interplay between mathematics anxiety and numeracy literacy, as it provided a real-life context where both issues were evidently present.

Participants

The participants consisted of all 20 students enrolled in Class VII A, aged between 12 and 13 years. From this group, six students were purposively selected as focal subjects for in-depth analysis. The selection was based on the results of the mathematics anxiety questionnaire, ensuring representation from the three levels of anxiety: two students with low anxiety, two with moderate anxiety, and two with high anxiety. This sampling strategy allowed the researchers to capture variations in students' numeracy literacy performance across different anxiety levels. The focus on six participants aligns with the principles of case study research, which prioritize depth of exploration over breadth, enabling detailed examination of individual learning experiences and the factors influencing them.

Instruments

Three instruments were employed in this study: (1) a mathematics anxiety questionnaire, (2) a numeracy literacy test, and (3) a semi-structured interview guide.

Mathematics Anxiety Questionnaire

The mathematics anxiety questionnaire was designed to classify students into low, moderate, and high anxiety categories. The instrument consisted of 13 items rated on a four-point Likert scale, with scores ranging from 1 (strongly agree) to 4 (strongly disagree). Positive and negative items were scored inversely to minimize response bias. The total score range was 13 to 52, with three categories of mathematics anxiety: low (13–25), moderate (26–38), and high (39–52). Example items included: *"I feel confident when working on mathematics problems"* (positive) and *"I become nervous when asked to solve a math problem in front of the class"* (negative). Content validity was established through expert judgment involving a mathematics education lecturer and an educational psychology lecturer, who evaluated clarity, readability, and alignment with the constructs of mathematics anxiety. A pilot test was also conducted to check internal consistency, yielding a Cronbach's Alpha of 0.82, which indicated good reliability.

Numeracy Literacy Test.

The numeracy literacy test consisted of five contextual word problems related to two-dimensional geometry, designed to reflect real-life applications of mathematics. The test measured three indicators adapted from Lusiana et al. (2025): (1) the ability to use mathematical concepts, numbers, and symbols related to two-dimensional shapes; (2) the ability to analyze information presented in various geometric forms; and (3) the ability to interpret analytical results to make predictions and decisions. These indicators were selected because they align with the Indonesian junior secondary mathematics curriculum and are consistent with international numeracy frameworks (e.g., OECD, PISA). An example item asked students to determine the area of a composite figure representing a park layout. Students' responses were evaluated using a rubric with three levels of achievement: high (score 3), moderate (score 2), and low (score 1). Inter-rater reliability was established by having both a mathematics education lecturer and a practicing mathematics teacher independently score a sample of responses, with an agreement rate of 87%. Both the test and rubric were revised according to their feedback to ensure content validity and appropriateness for seventh-grade students.

Semi-structured Interview Guide

Individual semi-structured interviews were conducted with the six focal participants to gain deeper insights into their problem-solving processes and emotional experiences when engaging with mathematics tasks. The interview guide contained open-ended questions focusing on three areas: (1) students' reasoning strategies in solving geometry problems, (2) their emotional responses and experiences of anxiety during mathematics learning, and (3) reflections on how anxiety influenced their ability to interpret, analyze, and solve problems. Each interview lasted approximately 20–30 minutes and was audio-recorded with participants' consent. Thematic coding was later applied to identify recurring patterns across cases.

Trustworthiness of Instruments.

To enhance the credibility and trustworthiness of the instruments, multiple validation steps were undertaken: content validity (expert review), reliability checks (Cronbach's Alpha for the questionnaire and inter-rater agreement for the rubric), and method triangulation (cross-verification of questionnaire, test, and interview results). These procedures ensured that the instruments were not only theoretically sound but also empirically reliable for capturing students' numeracy literacy and mathematics anxiety.

Data Collection

Data collection was carried out in three sequential stages: administration of the mathematics anxiety questionnaire, the numeracy literacy test, and individual semi-structured interviews. The questionnaire and test sessions were completed within one 60-minute class period, while each interview lasted approximately 20–30 minutes and was audio-recorded with consent. The questionnaire data were used to categorize students into anxiety levels, the test data provided evidence of numeracy literacy performance across three indicators, and the interview data offered deeper insights into students' reasoning strategies and emotional experiences.

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Data Analysis

Data analysis proceeded through three iterative stages: data reduction, data display, and conclusion drawing and verification. Students' written responses were scored with the rubric and classified into three levels for each indicator, while interview transcripts were thematically coded to capture recurring patterns of reasoning, problem-solving, and anxiety-related behaviors. Coding was performed manually by the researcher, with inter-coder discussions conducted with a peer reviewer to strengthen reliability. Triangulation of methods (questionnaire, test, interview) and data sources (students across different anxiety levels) was applied to enhance credibility. Dependability was ensured through systematic documentation of research procedures, and confirmability was maintained through transparent data tracking and audit trails. This study adhered to institutional and international ethical guidelines for research involving minors. Approval was obtained from the school principal, and informed consent was secured from both the students and their parents prior to participation. Participation was voluntary, and students were informed of their right to withdraw at any stage without consequence. All data were treated with strict confidentiality, and participants' identities were anonymized during analysis and reporting to protect their privacy.

Results

The study was conducted at SMPS Babul Istiqamah from May 8 to May 15, 2025, in Class VII A with 20 students enrolled. During data collection, only 15 students were present, while five students were absent due to illness. Subject selection was based on mathematics anxiety questionnaire scores and the results of the numeracy literacy test. The distribution of students across anxiety categories and their test scores is presented in Table 1.

Table 1. Students' Mathematics Anxiety and Numeracy Literacy Scores

No	Initials	Anxiety Category	Anxiety Score	Numeracy Literacy Score
1	AU	High	39	31
2	SZ	Low	18	44
3	AR	Moderate	32	27
4	EM	Moderate	36	24
5	JN	Low	25	100
6	KNS	Moderate	34	42
7	MAA	Low	24	13
8	MBA	High	45	7
9	MF	High	39	13
10	QNR	Moderate	35	33
11	RA	High	41	18
12	SM	Low	25	60
13	SK	High	41	13
14	SV	Moderate	31	38
15	TAA	Moderate	32	18

As shown in Table 1, numeracy literacy among the students was generally low. Six students fell into the moderate anxiety category, five students into the high category, and four students into the low category. From these groups, six students were selected as focal subjects for further analysis: two with high anxiety (MBA and SK), two with moderate anxiety (KNS and SV), and two with low anxiety (JN and SZ).

Low-Anxiety Group

Based on the results of the written test and follow-up interview conducted with JN, a student categorized with low mathematics anxiety, it was found that JN successfully demonstrated the first indicator of numeracy literacy, namely the ability to use a variety of mathematical concepts, symbols, numbers, and formulas related to two-dimensional geometry. This was evident in JN's ability to correctly identify and apply the formula for the area of a kite ($\frac{1}{2} \times d_1 \times d_2$). JN also demonstrated competence in analyzing the information presented in the problems. In problem number 5, JN again met the indicators of numeracy literacy by applying the formula for the area of a circle ($\pi \times r^2$) to calculate the area of a pond, subtracting this from the total land area to determine the remaining space, and dividing the result by the area required for each palm tree to obtain the total number of trees that could be planted. JN demonstrated strong analytical skills (indicator two) by accurately processing the given information, and in terms of the third indicator, JN was able to interpret the analysis to make predictions and logical decisions. JN concluded correctly that 130 palm trees could be planted in the remaining land area. This shows that the subject was able to make appropriate decisions based on accurate mathematical reasoning and calculations.

Interview with Subject JN

R	Do you understand the meaning of questions 2 and 5?
JN	Yes, I understand.
R	What do you understand from them?
JN	To find the area of the kite and to determine how many palm trees can be planted
R	What do you understand from them?
JN	To find the area of the kite and to determine how many palm trees can be planted
R	What information is provided in the questions?
JN	In question 2, it is given that diameter 1 is 20 cm and diameter 2 is 15 cm, and the problem asks for the area of paper needed to make a kite. In question 5, it is given that the total land area is 600 square meters, the radius of the pond within the land is 5 m, and the distance between trees is 4 m. The problem asks how many palm trees can be planted.
R	Please explain how you solved questions 2 and 5?
JN	For question 2, first I wrote down what was given and what was being asked. Then I calculated the area of the kite using the formula $\frac{1}{2} \times d_1 \times d_2$. Since diameter 1 was 20 cm and diameter 2 was 15 cm, I multiplied $\frac{1}{2} \times 20 \times 15$. For question 5, after identifying the given information and the problem to be solved, I calculated the area of the pond using $\pi \times r^2$. Then I subtracted the pond area from the total land area to determine the remaining land. Finally, I divided the remaining land area by the space required per tree to find the number of palm trees that could be planted.
R	Do you think there is another, more effective way to solve these problems?
JN	No
R	Do you feel you understand the mathematical concepts used in these problems?
JN	I understand them well enough.

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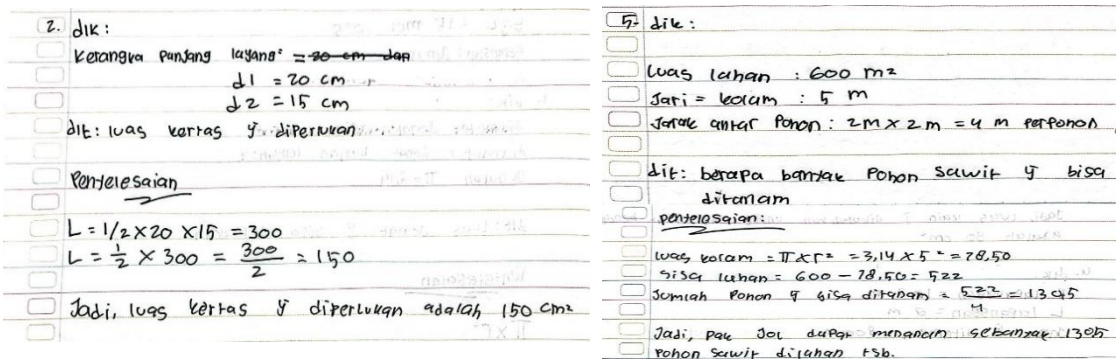

Figure 1. Student JN's Responses to Test Questions No. 2 and 5

Based on the results of the written test and the follow-up interview with subject SZ, it was found that SZ successfully demonstrated the first indicator of numeracy literacy, namely the ability to use various mathematical concepts, symbols, numbers, and formulas related to two-dimensional geometry. This was evident in SZ's ability to accurately identify and apply the formula for the perimeter of a rectangle, calculated as 2 × (length + width). Regarding the second indicator, SZ was also able to analyze the information provided in the problem, such as the length and width of the field and the total distance covered by Desi. For the third indicator, which concerns the ability to interpret analytical results to make predictions and decisions, SZ demonstrated a good level of understanding. SZ concluded that Desi circled the field 20 times, based on the comparison between the total distance traveled and the calculated perimeter of the field. This decision was grounded in accurate calculations. Overall, SZ successfully solved the problem and demonstrated a solid understanding of the mathematical concepts involved.

Interview with Subject SZ

R	What did you understand from question 4?
SZ	To calculate the perimeter of the field, and to determine how many times Desi ran around the field.
R	What information was provided in question 4?
SZ	The information was about the length and width of the field, and the total distance covered by Desi.
R	Can you explain how you solved question 4?
SZ	Yes, I can.
R	Please explain.
SZ	First, I calculated the perimeter, since the field is rectangular. The formula is perimeter = 2 × (length + width). The length was given as 12 m and the width as 8 m, so I added them first, 12 + 8 = 20 m, and then multiplied by 2 to get 40 m. Since Desi ran a total distance of 800 m, the question was how many times she circled the field. So I divided the total distance by the perimeter: 800 ÷ 40 = 20. That means Desi circled the field 20 times
R	Do you understand the mathematical concept used in this problem?
SZ	Yes, I do.
R	Do you think there is a more effective way to solve this problem?
SZ	No, there isn't.

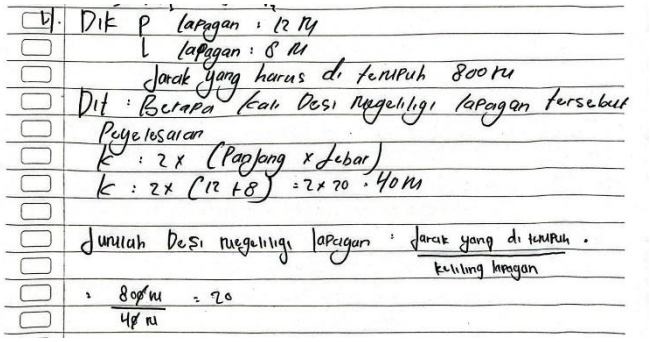

Figure 2. Student SZ's Response to Test Question No. 4

Moderate-Anxiety Group

Based on the results of the written test and follow-up interview with subject KNS, it was found that KNS fulfilled the first indicator of numeracy literacy, namely the ability to use various mathematical concepts, symbols, numbers, and formulas related to two-dimensional geometry. This was demonstrated through KNS's understanding of the concept of the area of a circle using the formula $\pi \times r^2$. KNS was able to calculate the radii from both the outer and inner diameters of a donut-shaped figure and then compute the area of each circle accurately. For the second indicator, KNS was able to analyze the information presented in the problem by identifying the given data (such as the outer and inner diameters of the donut) converting them into radii, and then calculating the areas of the two circles. This information was subsequently used to determine the edible area of the donut by subtracting the inner circle's area from the outer circle's area. Regarding the third indicator, KNS was able to interpret the analytical results to generate predictions and logical decisions. KNS concluded that the edible area of the donut was the result of subtracting the two calculated areas. Although there were minor inconsistencies in the final numerical result, these were attributed more to emotional conditions during problem-solving rather than a lack of conceptual understanding. In conclusion, KNS demonstrated numeracy literacy skills across all three indicators, although further support is needed in managing emotions and improving accuracy when working under pressure.

Interview with Subject KNS

R	What did you understand from question 1?
KNS	It was about a donut, how to calculate the area of the donut.
R	What information was provided in question 1?
KNS	The information was the diameters of the donut, and how much of the donut area can be eaten.
R	Can you explain how you solved question 1?
KNS	First, I found the radii of both diameters of the donut. After finding the radii, I calculated the areas of both parts of the donut using the formula $\pi \times r^2$. Then, to find the edible area of the donut, I subtracted the area of the inner circle from the area of the outer circle.
R	Do you fully understand the mathematical concept used in this problem?
KNS	Only partly.

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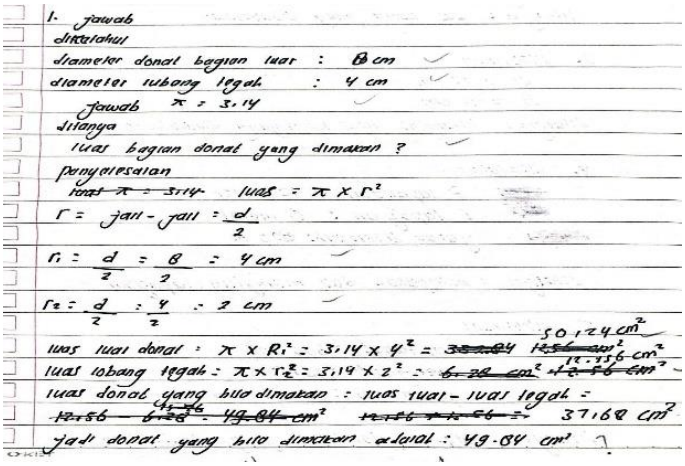

Figure 3. Student KNS's Response to Test Question No. 1

Based on the results of the written test and the interview, it was found that SV did not fully meet the first indicator of numeracy literacy, namely the ability to apply a range of concepts related to two-dimensional geometry. Although SV was able to correctly state the formula for the area of a triangle (½ × base × height), the subject did not fully understand how to apply it in solving the problem. This indicates that SV's basic conceptual understanding still needs to be strengthened. With regard to the second indicator, the ability to analyze information presented in the problem, SV was only able to identify partial information, such as the base length and the height of the flag, but was unable to process this information into a solution. This suggests that SV still experienced difficulties in understanding the relationship between the given information and the problem-solving steps. For the third indicator, the ability to interpret analytical results in order to make predictions and decisions, SV was unable to demonstrate this skill. SV failed to draw conclusions from the problem-solving process. Interview data revealed that SV felt dizzy while working on the task, which directly affected the ability to concentrate and think clearly. These feelings significantly disrupted SV's cognitive process, leading to an inability to complete the task.

Interview with Subject SV

R	What did you understand from question 3?
SV	I did not really understand.
R	Did you understand the information presented in question 3?
SV	Only a little.
R	What information was given in question 3?
SV	It stated the length of the flag's base and its height, and asked for the area of cloth needed to make a triangular flag.
R	How do we calculate the area of a triangle?
SV	½ × base × height.
R	Do you understand how to apply the formula for the area of a triangle?
SV	Not really.
R	Which part do you not understand?
SV	I don't understand how to solve it.
R	What did you feel while working on this problem?
SV	Dizzy.
R	Did that feeling affect your ability to solve the problem?
SV	Yes, it did.
R	How did the dizziness affect you?
SV	I was unable to think and could not concentrate.

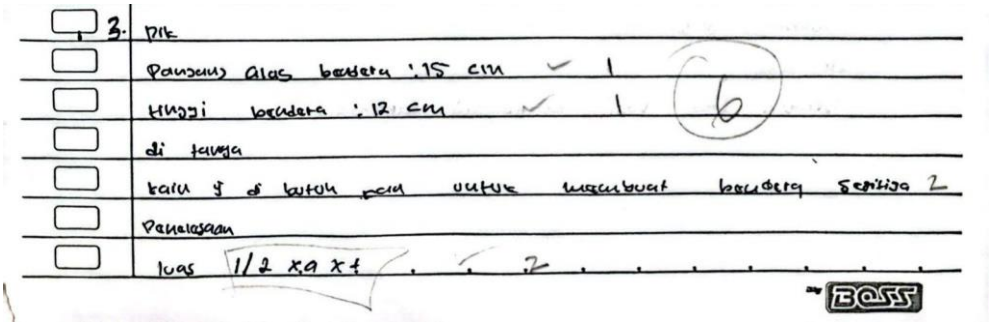

Figure 4. Student SV's Response to Test Question No. 3

High-Anxiety Group

Based on the results of the written test and the interview, it was found that MBA did not meet any of the three indicators of numeracy literacy. This was evident from MBA's own admission of not fully understanding the material and merely answering the questions by following the approach of peers. Although the written response showed an attempt to apply the formula for the area of a circle, this was not derived from personal understanding and therefore did not reflect independent mastery of the mathematical concept. For the second indicator, MBA also failed to demonstrate competence. The student was unable to identify and process the information provided in the problem, such as the outer diameter and the inner diameter of the donut. A lack of understanding of the basic concepts became the primary obstacle to analyzing the given information. Regarding the third indicator, the ability to interpret analytical results to make predictions and decisions, MBA was also unable to demonstrate this skill. Due to limited conceptual understanding and inability to carry out the problem-solving process, MBA could not interpret the expected results or draw logical conclusions. The interview further revealed that feelings of low self-confidence, fear of making mistakes, and anxiety toward the mathematics teacher significantly influenced MBA's ability to understand the material and complete the tasks. These emotional factors also contributed to MBA's difficulty in concentrating and developing mathematical reasoning skills.

Interview with Subject MBA

R	What did you understand from question 1?
MBA	I didn't understand.
R	Which part did you not understand?
MBA	All of it.
R	But why were you able to write a little answer on your test paper?
MBA	I just followed what my friend did
R	So your answer was based on your friend's work?
MBA	Yes.
R	What made you unable to understand this problem?
MBA	I didn't understand the material
R	What did you feel while working on this problem?
MBA	I felt insecure and afraid of making mistakes.
R	Do you think the anxiety you experienced affected your ability to understand the material and solve the problem?
MBA	Yes, it did.
R	How did it affect you?
MBA	I couldn't understand the material properly and was unable to answer the question.

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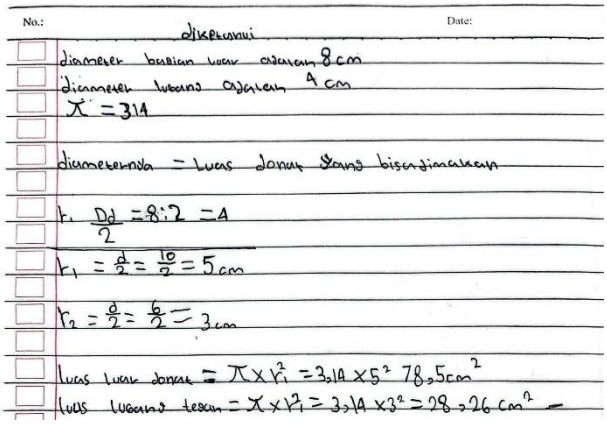

Figure 5. Student MBA's Response to Test Question No. 1

Based on the results of the written test and the interview, it was found that SK did not fully meet the first indicator of numeracy literacy, namely the ability to apply various concepts, symbols, numbers, and formulas related to two-dimensional geometry. SK only demonstrated a limited understanding of how to find the radius of a circle by dividing the diameter by two but was unable to proceed to the stage of calculating the area or applying the appropriate formula to solve the problem. This indicates that SK's conceptual understanding of mathematics remains very basic and incomplete. Regarding the second indicator, the ability to analyze information presented in the problem, SK was also unable to identify and process important information such as the outer and inner diameters of the donut, nor did the student realize that this information was directly related to the process of calculating the area. When asked about the content of the question, SK admitted not knowing and feeling confused, which indicated that the ability to analyze data in the context of two-dimensional geometry had not been achieved. For the third indicator, the ability to interpret analytical results in order to make predictions and decisions, SK was also unable to demonstrate this skill because the student could not continue the calculation process or draw conclusions from the information provided. The interview further revealed that SK experienced dizziness while working on the task, caused by a lack of understanding of the material. This feeling affected SK's ability to think clearly, making it difficult to comprehend the problem, reason logically, and complete the task effectively.

Interview with Subject SK

R	What did you understand from question 1?
SK	Not much. I only understood how to find the radius of the donut.
R	Can you explain how to find the radius of the donut?
SK	To find the radius of the donut, you divide the given diameter by two.
R	What information was provided in the problem?
SK	I don't know.
R	What did you feel while solving this problem?
SK	Dizzy.
R	Why did you feel dizzy?
SK	Because I didn't understand.
R	Did you find it difficult to understand the problem while feeling dizzy?
SK	Yes, it was difficult.
R	Did that feeling affect you?
SK	Yes, it did.
R	How did it affect you?
SK	I couldn't answer the question, and I didn't understand it.

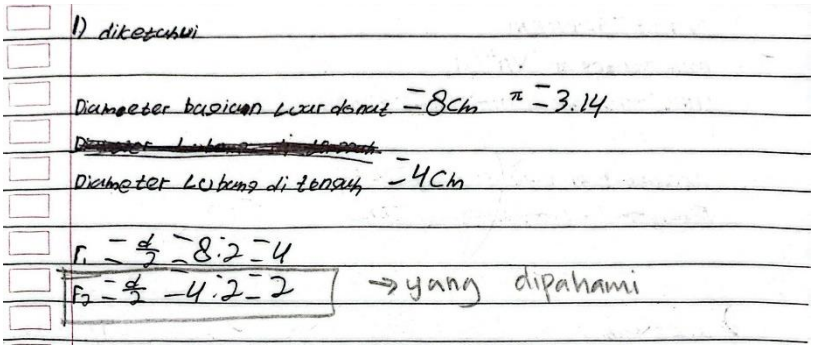

Figure 6. Student SK's Response to Test Question No. 1

Discussion

Students with low mathematics anxiety demonstrated relatively strong numeracy literacy skills. Both students in this category successfully met the three indicators of numeracy literacy, namely the ability to apply mathematical concepts, formulas, and symbols accurately, to analyze problem information systematically, and to interpret analytical results to reach logical conclusions. Their performance was reflected not only in written answers but also in oral explanations, showing that they could justify their reasoning and contextualize results. This finding supports previous studies by Setiawan et al. (2021), who reported a negative correlation between mathematics anxiety and problem-solving ability, and by Harefa et al. (2023), who argued that students with low anxiety tend to perform better because they are able to think more clearly and systematically. In practical terms, low-anxiety students may benefit from enrichment strategies that sustain their motivation and extend their higher-order reasoning abilities (Vidic et al., 2022).

In contrast, students with moderate mathematics anxiety revealed more heterogeneous outcomes. One student in this category was able to meet all three indicators, indicating that moderate anxiety did not entirely hinder performance. This aligns with Handayani (2019), who noted that moderate anxiety may function as a motivational driver that encourages students to seek alternative strategies. However, the second student with moderate anxiety showed significant difficulties across all indicators, particularly in applying formulas, analyzing complete information, and drawing conclusions. Interviews revealed that affective disturbances such as dizziness and loss of concentration interfered with their reasoning. This is consistent with Lusiana et al. (2025), who emphasized that mathematics anxiety can disrupt logical reasoning and problem-solving processes. Therefore, students with moderate anxiety may require a balanced pedagogical approach that combines cognitive scaffolding with strategies to manage anxiety, so that anxiety remains at a productive rather than a debilitating level.

Students with high mathematics anxiety consistently failed to meet the three indicators of numeracy literacy. They struggled with understanding and applying basic mathematical concepts, analyzing problem information, and interpreting results to make decisions. One student admitted to copying answers from peers without comprehension, while another only partially understood how to find a radius but was unable to proceed to more complex steps. These difficulties were reinforced by interviews that highlighted feelings of fear, lack of confidence, and physiological discomfort such as dizziness, which directly hindered concentration and reasoning. Such findings confirm earlier research by Anggarawati et al. (2023), Setiawan et al. (2021), and Mutik et al. (2025), who emphasized the negative impact of high mathematics anxiety on cognitive processing, as well as the neuropsychological

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explanation by Tobu & Hadisusanto (2022) that excessive amygdala activation under anxiety interferes with information processing and conceptual understanding. Practically, these students require intensive interventions focused on reducing anxiety through supportive teacher-student interactions, positive feedback, and strategies for rebuilding mathematical confidence.

Taken together, the results suggest a gradient relationship between mathematics anxiety and numeracy literacy: low anxiety is associated with high literacy performance, moderate anxiety produces mixed outcomes, and high anxiety leads to consistently poor performance. This pattern reinforces the view that mathematics anxiety is not merely an affective variable but a cognitive-affective construct that directly influences reasoning, problem-solving, and decision-making (Tall et al., 2014). Theoretically, the findings extend the literature on numeracy literacy by emphasizing the mediating role of emotional regulation in enabling or obstructing mathematical reasoning (Heyd-Metzuyanim et al., 2021). Practically, the study highlights the necessity for differentiated pedagogical approaches: enrichment for low-anxiety students, scaffolding combined with emotional support for moderate-anxiety students, and intensive interventions for highly anxious students (Hein & Prediger, 2024; Kosko, 2020). Such differentiation ensures that instruction does not adopt a "one-size-fits-all" approach but instead addresses the cognitive and emotional profiles of learners, ultimately contributing to the development of more effective mathematics pedagogy.

Conclusion

This study revealed a clear gradient between mathematics anxiety and numeracy literacy among seventh-grade students. Learners with low anxiety demonstrated strong numeracy literacy across all indicators, those with moderate anxiety displayed mixed outcomes where anxiety sometimes functioned as a motivator and sometimes as a barrier, while students with high anxiety consistently struggled to apply mathematical concepts, analyze information, and draw logical conclusions. These findings contribute theoretically to the literature by emphasizing the intertwined cognitive–affective nature of numeracy literacy, showing how emotional regulation can mediate mathematical reasoning. Practically, the study highlights the need for differentiated pedagogical strategies, enrichment for low-anxiety learners, scaffolding and anxiety management for those with moderate anxiety, and intensive, confidence-building interventions for highly anxious students. Nevertheless, this study has several limitations. The small sample size and focus on a single school limit the generalizability of the findings. In addition, the qualitative case study design provides depth but not breadth, and thus future research should combine qualitative and quantitative approaches with larger, more diverse samples to validate the patterns observed. Longitudinal studies are also recommended to examine how mathematics anxiety and numeracy literacy interact over time. Expanding the investigation across different grade levels and socio-cultural contexts would further enrich understanding and strengthen the development of targeted pedagogical interventions.

Conflict of Interest

The authors declare that there is no conflict of interest.

Author Contributions

A.H. conceptualized the research idea, designed the study, collected the data, and drafted the manuscript. H.K. supervised the research process, provided guidance on methodology, contributed to data analysis, and critically revised the manuscript. Both authors discussed the results together and approved the final version of the paper. The percentage contributions to the

conceptualization, drafting, and revision of this manuscript are as follows: A.H.: 70% and H.K.: 30%.

Data Availability Statement

The authors state that the data supporting the findings of this study are available from the corresponding author, [A.H.], upon reasonable request.

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