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Analysis of the numeracy abilities of class VIII students solve AKM questions

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ABSTRACT

This study aims to describe the numeracy skills of eighth-grade students at SMP Negeri 4 Kotabumi in solving AKM-based problems. The study was motivated by the relatively low numeracy skills of students in solving problems that require reasoning and problem-solving abilities. Numeracy is an essential competency assessed through the Minimum Competency Assessment (AKM), encompassing the ability to analyze information, apply numbers or mathematical symbols in mathematical contexts, and make decisions based on quantitative data in everyday life. This study employed a qualitative descriptive approach involving eighth-grade students of class VIII D at SMP Negeri 4 Kotabumi during the 2025/2026 academic year. A total of 22 students participated in the numeracy skills test, after which six students representing high, moderate, and low ability categories were purposively selected as interview subjects. The research instruments consisted of essay questions adapted from AKM items and interview guidelines. Data were analyzed through three stages: data condensation, data display, and conclusion drawing. Methodological triangulation was employed to verify the findings by comparing the results of the numeracy test and interviews. The results showed that 18 out of 22 students (81.82%) were still classified as having low numeracy skills. Students in the low-ability category had not yet demonstrated all three numeracy indicators. Students in the moderate-ability category were able to demonstrate two indicators, whereas students in the high-ability category were able to demonstrate all three numeracy indicators.

1.Introduction

Numeracy is closely associated with the ability to understand, apply, and interpret mathematical concepts in real-life contexts and constitutes one of the essential foundational competencies for students [1,2]. More specifically, numeracy can be defined as an individual's capacity to use mathematical numbers and symbols, evaluate data presented in various formats such as tables, diagrams, and graphs, and make informed decisions when addressing problems encountered in real-world contexts [3]. Dapat dikatakan bahwa kemampuan numerasi ini tidak hanya mencakup kemahiran dalam operasi Matematika dasar, tetapi Thus, numeracy encompasses not only proficiency in basic mathematical operations but also the ability to engage in logical reasoning, analyze data, solve problems, and apply mathematical ideas in practical

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contexts. This competency serves as an important foundation for developing mathematical literacy, enabling students to make appropriate decisions based on available quantitative information [4]. In practice, individuals who are able to evaluate, reason about, and communicate mathematical concepts effectively can be considered to possess a high level of numeracy. These abilities are essential for active participation in modern society, which increasingly relies on data and numerical information, as well as for making informed and appropriate decisions across various areas of life [5].

The Ministry of Education, Culture, Research, and Technology, as the government institution responsible for education in Indonesia, has continued to promote innovations aimed at improving the quality of education. One of these initiatives is the development of an assessment instrument to measure students' literacy and numeracy skills, known as the Minimum Competency Assessment (AKM) [3]. AKM is designed to assess students' abilities in higher-order cognitive processes, problem solving, and the application of concepts in real-life contexts, rather than merely testing their ability to memorize mathematical formulas or procedures. The implementation of AKM is expected to encourage students to develop higher-order thinking skills and contribute to the continuous improvement of the quality of education in Indonesia [6]. This aligns with the view that AKM is a relevant assessment instrument for evaluating students' actual numeracy skills [7]. For students, AKM serves as a means of evaluating foundational skills needed for personal development and constructive participation in society [8]. The assessment of numeracy through AKM is based on two fundamental domains, namely literacy and numeracy, which encompass cognitive processes, content, and context. These three components are designed to support students in developing stronger reasoning abilities when solving problems presented in AKM items [9].

Based on the foregoing discussion, AKM plays an important role in supporting the development of students' numeracy skills and contributing to the improvement of education in Indonesia. However, in practice, the implementation of AKM as a means of assessing and evaluating students' numeracy skills has not been fully utilized by all schools. This situation is also observed at the school where the present study was conducted. According to information provided by a mathematics teacher, Ms. Evi, who teaches at SMP Negeri 4 Kotabumi, the school, particularly at the classroom level, had not previously conducted an in-depth assessment or analysis using AKM-based problems to measure students' numeracy skills. Consequently, information describing students' abilities to solve problems requiring reasoning and contextual problem-solving remains limited.

Previous studies have examined students' numeracy skills in solving AKM-based problems across various educational levels. However, studies specifically investigating the numeracy skills of eighth-grade students at SMP Negeri 4 Kotabumi have not yet been identified. Accordingly, the present study contributes a contextual perspective by examining students' numeracy skills at SMP Negeri 4 Kotabumi, a school in which AKM-based numeracy mapping had not previously been conducted. The findings are expected to provide empirical information regarding students' numeracy skills, particularly their ability to apply reasoning and solve contextual problems.

Eighth-grade students represent an important age group for the development of numeracy skills, as they are in a transitional phase toward higher levels of education. At this stage, a strong understanding of numeracy concepts is essential for preparing students to engage with more complex content in the future, not only in mathematics but also in other subjects that require quantitative reasoning. Nevertheless, national and international assessments indicate that students' numeracy performance in Indonesia remains a concern. The Programme for International Student Assessment (PISA) reported that Indonesia obtained a mathematics literacy score of 366, which was substantially lower than the international average of 472. In terms of mathematics and numeracy literacy, approximately 82% of Indonesian students were also reported to perform below Level 2 [10]. These findings indicate that Indonesian students' performance in mathematics and numeracy remains below the level demonstrated in many other participating countries. This condition is further supported by a report from the Center for Educational Assessment (Pusmendik) in 2024, which showed that the average numeracy scores of Indonesian students increased from 58.03 in 2021 to 65.68 in 2022 and 74.36 in 2023 [11]. Although this increase indicates improvement in students' achievement, further development is still needed, particularly because students' numeracy performance continues to vary considerably. One factor that may contribute to this variation is students' relatively limited mathematical ability [11]. Previous studies have also reported that approximately 62.50% of students were classified as having low numeracy skills, partly because they experienced difficulties in applying the three indicators of numeracy [6,12].

As part of the government's continuing efforts to improve the quality of education following the implementation of AKM, the Indonesian government has also introduced the Academic Competency Test (TKA), a standardized assessment of students' academic achievement. TKA is administered by the Ministry of Primary and Secondary Education (Kementerian Pendidikan Dasar dan Menengah/Kemendikdasmen) and is conducted entirely through a computer-based system. The subjects assessed in TKA include Indonesian Language and Mathematics, as both are considered essential foundations for the development of students' literacy and numeracy skills [13]. In this regard, TKA can serve as a reference for reflecting on students' learning outcomes and evaluating efforts to improve educational

quality. Based on the 2025 TKA results, the national average Mathematics score remained relatively low at 36.10, while the average Mathematics score of students in Lampung Province was 34.64, which was below the national average [14]. These TKA results provide supporting information regarding students' general mathematical achievement. However, the present study specifically focuses on students' numeracy skills in answering questions and solving problems presented in AKM-based items.

The foregoing findings indicate that students in Indonesia continue to face challenges related to low numeracy achievement. This situation is reflected in the relatively low numeracy performance and academic assessment results, both of which are associated with fundamental competencies in mathematics. The TKA results also show that the average Mathematics score in Lampung Province was below the national average, suggesting that students' mathematical achievement in the province remains an area that warrants further attention. Therefore, it is important to analyze students' numeracy skills at a junior high school in Lampung to obtain an objective description of their foundational abilities in understanding mathematical concepts and solving problems that require critical thinking [5]. The qualitative approach employed in this study enables an in-depth exploration of students' responses and reasoning processes when solving problems, as well as an examination of their ability to solve AKM-based problems that assess not only conceptual knowledge but also reasoning and problem-solving skills in real-world contexts.

Given the importance of numeracy as a fundamental competency and the continuing concerns regarding students' numeracy performance in Indonesia, this study was conducted at SMP Negeri 4 Kotabumi, North Lampung Regency, to examine students' numeracy skills in solving AKM-based problems. The study aims to provide a more in-depth description of students' abilities to understand, reason about, and solve AKM-based problems. The findings are expected to provide useful empirical information for supporting efforts to strengthen students' numeracy skills. Furthermore, the findings may serve as a reference for schools and other relevant stakeholders in evaluating existing learning practices and developing educational initiatives aimed at improving students' numeracy skills.

2. Method

This study employed a qualitative descriptive approach to describe and examine the numeracy skills of eighth-grade students at SMP Negeri 4 Kotabumi during the 2025/2026 academic year in solving AKM-based problems [15]. Quantitative data were also presented as supporting information to strengthen the description and interpretation of the research findings. The research participants were selected using purposive sampling based on discussions with and recommendations from the mathematics teacher at the school, taking several considerations into account. The study was conducted in class VIII D, consisting of 22 students. The numeracy test was administered in May 2026 during a regular mathematics lesson, with a 10-minute time limit. The test was supervised by both the mathematics teacher and the researcher. After the students completed the AKM-based test, their responses were assessed and classified according to their numeracy skill levels. Subsequently, semi-structured interviews were conducted with six students selected based on their test scores. Two students were selected from each numeracy category: high; moderate; and low, to represent the range of numeracy skills within the class. The interviews were conducted individually in the classroom with the consent of the respective students. The interviews were conducted sequentially, beginning with students in the high numeracy category and proceeding to those in the moderate and low categories. The interviews were intended to obtain a deeper understanding of students' numeracy skills, support the interpretation of the test findings, and validate the results obtained from the numeracy test.

The research instruments consisted of an AKM-based open-ended test and an interview guide. The AKM-based test comprised one item covering the content domain of geometry and measurement, specifically the Pythagorean Theorem, adapted from [16]. In addition, a semi-structured interview guide was used to obtain more detailed information regarding students' numeracy skills. The semi-structured interview consisted of open-ended questions while referring to the three numeracy indicators used in this study. The interview guide was reviewed in consultation with a lecturer from the Mathematics Education Study Program and approved by one of the mathematics teachers at the research site. The indicators used to describe students' numeracy skills in this study were based on Han et al., as cited in [6], as presented in the following table.

Table 1
Indicators of Students' Numeracy Skills

No	Indicator
1	Students are able to analyze information presented in various forms, such as graphs, tables, charts, and diagrams.
2	Students are able to apply numbers or mathematical symbols related to basic mathematics to solve problems encountered in everyday life.
3	Students are able to interpret the results of their analysis to make predictions and appropriate final decisions.

The students' numeracy skills were categorized based on their scores on the AKM-based test. The classification criteria were adapted from [17] as presented in Table 2.

Table 2
Categories of Students' Numeracy Skills

Score Range	Categori
71–100	High numeracy skills
41–70	Moderate numeracy skills
≤ 40	Low numeracy skills

The data analysis process consisted of three stages based on [18]: data condensation, data display, and conclusion drawing. Methodological triangulation was employed to verify the data by comparing the results of the AKM-based test and interviews. During the data condensation stage, data were collected from field sources, including students' responses to the open-ended AKM-based test administered in class and interviews with six students representing different numeracy skill categories. The test and interview data were compared to examine the consistency between students' written responses and their explanations during the interviews, while also reducing and organizing the information relevant to the research objectives. The next stages involved data display and conclusion drawing. At the data display stage, the research findings were categorized and presented using a combination of numerical data, tables, and narrative descriptions to facilitate data interpretation. The findings were then examined and synthesized to provide a clear description of the students' numeracy skills in solving AKM-based problems.

3. Results and discussion

The study was conducted with 22 eighth-grade students from class D at SMP Negeri 4 Kotabumi to describe their numeracy skills. The students completed an open-ended AKM-based test administered by the researcher in the classroom. The overall distribution of students' numeracy skill levels based on the test results is presented in Table 3.

Table 3
Results of the AKM-Based Numeracy Test

No	Score Range	Categori	Number of Students	Percentage (%)
1	71 – 100	High	2	9,09%
2	41 – 70	Moderate	2	9,09%
3	≤ 40	Low	18	81,82%

As shown in Table 3, the numeracy skills of the eighth-grade students at SMP Negeri 4 Kotabumi were predominantly classified as low, with 81.82% of the students obtaining scores below 40. This finding indicates that the majority of students, namely 18 students, were in the low numeracy category. Meanwhile, 9.09% of the students were classified as having moderate numeracy skills, and another 9.09% were classified as having high numeracy skills. These results indicate that most students experienced difficulties in solving AKM-based problems.

To support the findings and validate the test results, interviews were subsequently conducted with six students representing the three numeracy skill categories. The interviews were used to obtain a more in-depth understanding of students' numeracy skills based on their responses to the AKM-based problem. The following section presents selected examples of students' problem-solving responses to illustrate their numeracy skills in greater depth.

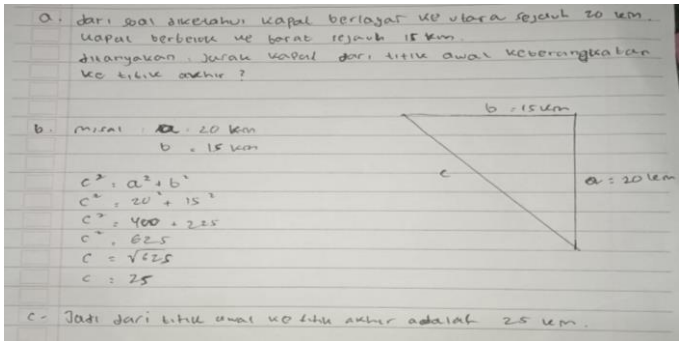


Fig 1. Answer Sheet of a Student in the High Numeracy Category

Based on Fig. 1, the student obtained the maximum score of 100. This result was achieved because the student was able to complete the problem accurately and provide the correct answer. The student's response is described according to the three numeracy indicators as follows.

1. Indicator 1: Analyzing information presented in various forms, such as graphs, tables, charts, and diagrams. In the first row of part (a) of the answer sheet, the student identified the information provided in the problem by stating that the ship sailed northward for 20 km and then turned westward for 15 km. The student also identified the information requested in the problem, namely the distance from the ship's initial position to its final position. The student was able to identify and present the relevant information from the problem completely and accurately. This response indicates that the student fulfilled the first numeracy indicator.
2. Indicator 2: Applying numbers or mathematical symbols related to basic mathematics to solve problems encountered in everyday life. In part (b), the student demonstrated a systematic problem-solving process by presenting a solution plan through a graphical illustration and mathematical modeling using the Pythagorean Theorem. The student also introduced letter symbols to represent the side lengths of the triangle corresponding to the ship's directions, namely $a = 20\,km$ for the northward direction and $b = 15\,km$ for the westward direction. The student then applied the Pythagorean Theorem to determine the length of side c, representing the hypotenuse of the previously constructed triangle. The calculations were presented in an orderly manner and resulted in a correct final answer. These findings indicate that the student fulfilled the second numeracy indicator by appropriately applying basic mathematical symbols and calculations to solve the problem.
3. Indicator 3: Interpreting analytical results to make predictions and appropriate final decisions. The student demonstrated good performance on the third indicator. This was evident from the final part of the answer sheet, where the student stated the value of c after checking the calculation obtained from the mathematical formulation. The student also provided a final conclusion based on the solution process. This response indicates that the student was able to interpret the result of the analysis and formulate an appropriate conclusion.

During the interviews, the two students who obtained scores within the 71 – 100 range were able to explain the information presented in the problem accurately, describe their problem-solving strategies using the Pythagorean Theorem, and arrive at appropriate conclusions. These findings indicate that both students were able to fulfill all three numeracy indicators. This finding is consistent with previous research showing that students who can accurately fulfill all three numeracy indicators when solving AKM-based problems tend to demonstrate high mathematical ability and reach the highest level of numeracy literacy, categorized as proficient [11]. The students' success in solving the problem was also supported by their foundational mathematical knowledge, particularly their understanding of how to select and apply appropriate formulas to solve problems situated in everyday contexts. Similarly, [19] reported that successful problem solving is influenced by students' ability to recognize and effectively apply mathematical concepts to contextual problems. Such abilities are important for supporting students in solving mathematical problems, particularly those situated in real-life contexts.

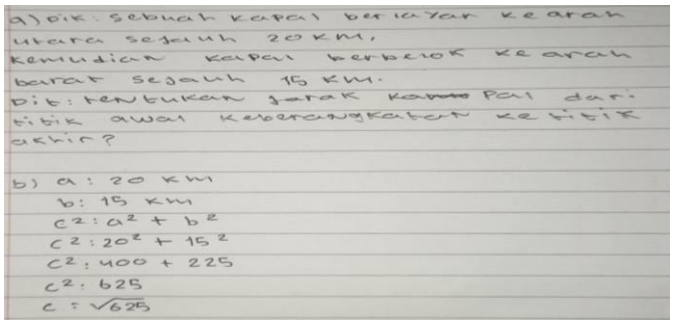


Fig 2. Answer Sheet of a Student in the Moderate Numeracy Category

As shown in Fig. 2, the student obtained a score of 60. This score reflects the student's ability to provide a complete response in part (a) and identify an appropriate problem-solving strategy in part (b), although the solution was not completed and the final answer was not provided. The student's response is described according to the three numeracy indicators as follows.

1. Indicator 1: Analyzing information presented in various forms, such as graphs, tables, charts, and diagrams. In part (a), the student identified the information provided in the problem by stating that the ship sailed northward for $20\,km$ and then turned westward for $15\,km$. The student also identified the information requested, namely the distance from the ship's initial position to its final position. The response indicates that the student was able to analyze and identify the relevant information from the problem completely and accurately. Therefore, the student fulfilled the first numeracy indicator.
2. Indicator 2: Applying numbers or mathematical symbols related to basic mathematics to solve problems encountered in everyday life. In part (b), the student presented a problem-solving strategy by constructing a mathematical model and applying the Pythagorean Theorem. The student assigned a = 20 km to the northward direction and b = $15\,km$ to the westward direction, and formulated the relationship as $c^2 = a^2 + b^2$ to determine the value of c. The strategy was appropriate; however, the student did not complete the calculation and therefore did not obtain the final result. These findings indicate that the student demonstrated a partial ability to fulfill the second numeracy indicator, as the appropriate mathematical symbols and formula were applied, although the solution process was incomplete.
3. Indicator 3: Interpreting analytical results to make predictions and appropriate final decisions. The student had not yet demonstrated the ability to interpret the results of the analysis and formulate an appropriate conclusion. This indicator was not fulfilled because the student did not complete the analysis and calculation to the final stage. Consequently, the student did not provide a conclusion or final answer to the problem.

Based on interviews with the two students whose scores ranged from 41 to 70, both students were able to identify relevant information from the problem and apply mathematical symbols and basic mathematical concepts in a real-life context. However, they experienced difficulties when asked to state the final conclusion as part of the problem-solving process. One student explained that the calculation could not be completed because determining the value of $\sqrt{625}$ required additional time. The other student stated that there was insufficient time to write the conclusion because the allotted test time had ended. These findings indicate that the students were classified as having moderate numeracy skills because they fulfilled two of the three numeracy indicators. Their difficulties in completing the final calculation prevented them from interpreting the results and formulating an appropriate conclusion. This finding is consistent with previous research indicating that students who experience difficulties in completing calculations and formulating conclusions from their solutions tend to fall within the moderate numeracy category [20].

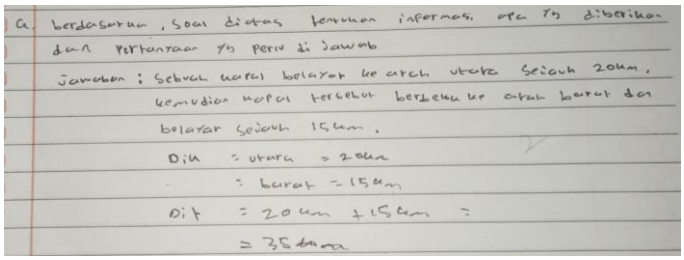


Fig 3. Answer Sheet of a Student in the Low Numeracy Category

As shown in Fig. 3, the student obtained a score of 20. This score reflects the student's partial ability to identify information from the problem, although the information provided was incomplete. In this category, several students submitted blank answer sheets, while others merely rewrote the information contained in the test item. The student's response in Figure 3 is analyzed according to the three numeracy indicators as follows.

1. Indicator 1: Analyzing information presented in various forms, such as graphs, tables, charts, and diagrams. In the answer sheet, the student identified some of the information provided in the problem by writing "North = 20 km," referring to

the ship sailing 20 km northward, and "West = 15 km," referring to the ship subsequently turning westward for 15 km. This indicates that the student was able to identify some of the given information. However, when identifying what was being asked, the student wrote "$20\ km + 15\ km = 35km$." This response was inaccurate because the student appeared to confuse the information requested in the problem with the total distance traveled. The question required the student to determine the distance from the ship's initial position to its final position, which represents the displacement and should be determined using the Pythagorean Theorem. Therefore, the student had not fully fulfilled the first numeracy indicator because the relevant information and the question being asked were not identified accurately and completely.

2. Indicator 2: Applying numbers or mathematical symbols related to basic mathematics to solve problems encountered in everyday life. The student did not present a clear problem-solving strategy, such as defining mathematical symbols, constructing a mathematical model, or applying an appropriate mathematical formula. Instead, the student wrote "$20\ km + 15\ km = 35\ km$" as the calculation. This response does not demonstrate an appropriate application of mathematical numbers or symbols because the operation does not correspond to the mathematical concept required to solve the problem. The calculation represents the total distance traveled rather than the distance from the initial position to the final position, which requires the application of the Pythagorean Theorem. Therefore, the student did not fulfill the second numeracy indicator.
3. Indicator 3: Interpreting analytical results to make predictions and appropriate final decisions. The student had not demonstrated the ability to interpret the results of the analysis and formulate an appropriate conclusion. This indicator was not fulfilled because the student was unable to identify the problem accurately or develop an appropriate strategy for solving it. As a result, the calculation was not completed using the required mathematical concept, and the student did not arrive at a valid final answer or conclusion. This condition may be associated with limitations in the student's mathematical knowledge and problem-solving ability. This interpretation is consistent with previous findings indicating that students' mathematical ability is one of the factors that may contribute to low numeracy performance [11].

During the interviews with students who obtained scores below 40, the students were found to experience difficulties in understanding the information presented in the problem. Some students stated that the problem was difficult, while others merely rewrote the test item. Several students also submitted blank answer sheets and explained that they had only rewritten the problem because they did not understand what was being asked. These findings indicate that the students did not fulfill any of the three numeracy indicators. This finding is consistent with previous research showing that students in the low numeracy category were unable to fulfill the numeracy indicators [21-27]. The difficulties experienced by the students may be associated with limited foundational mathematical knowledge. This was also supported by the mathematics teacher, who reported that many students in the class continued to experience difficulties with basic numerical operations, particularly multiplication, as well as with solving word problems such as AKM-type questions, which require a higher level of comprehension and reasoning. According to the teacher, these difficulties presented challenges in progressing to more advanced learning content. Students' difficulties in solving AKM-based problems may also be related to their limited experience with problems presented in narrative, graphical, or tabular forms. In classroom practice, students may have been more accustomed to problems involving basic calculations or the direct application of formulas that require relatively limited mathematical reasoning [22-30].

The analysis of test and interview data across the three numeracy skill categories revealed several findings regarding the characteristics of eighth-grade students' numeracy skills at SMP Negeri 4 Kotabumi in solving AKM-based problems. These findings not only support previous research but also provide a more specific description of the difficulties experienced by students across the three numeracy indicators. The main differences among the numeracy categories were particularly evident in the first and third indicators. Students in the moderate category, for example, continued to experience difficulties with the third indicator, namely interpreting analytical results and making appropriate decisions [31-36]. Although some students had obtained a result from the problem-solving strategy they had applied, they did not explicitly state the result as a final conclusion to answer the problem. In contrast, students in the low category demonstrated greater difficulties in analyzing the information presented in the problem. Although some students were able to identify the given information by writing it in the form of known quantities, they often misidentified or misunderstood the information being asked. These findings extend previous research by indicating that students' difficulties are not limited to understanding mathematical concepts but also involve interpreting calculation results and relating those results to the context of the problems presented in AKM-based items. The present study therefore contributes a detailed description of students' numeracy skills based on three numeracy indicators within the context of a school where AKM-based numeracy mapping had not previously been conducted. This information may serve as a reference for teachers in designing learning activities that place greater emphasis on interpretation and decision-making skills when solving contextual problems [37-44].

This study has several limitations. First, the number of participants was relatively limited, as the study involved only one class at a single school. Therefore, the findings cannot be generalized to students in different schools or educational contexts. Second, the research instrument consisted of only one open-ended AKM-based item focusing on a specific mathematical content area. Consequently, the instrument did not represent the full range of content domains and characteristics of AKM numeracy items.

4. Conclusion

The findings indicate that the majority of eighth-grade

students at SMP Negeri 4 Kotabumi had low numeracy skills. A total of 18 students (81,82%) obtained scores below 40 and were classified in the low numeracy category. These students were unable to fulfill all three numeracy indicators. Meanwhile, two students (9,09%) obtained scores ranging from 41 to 70 and were classified as having moderate numeracy skills. These students fulfilled two of the three numeracy indicators. The remaining two students (9,09%) obtained scores ranging from 71 to 100 and were classified as having high numeracy skills, demonstrating the fulfillment of all three numeracy indicators.

Students in the low numeracy category experienced difficulties that may be associated with limited understanding of foundational mathematical concepts, which serve as an important basis for numeracy development, as well as limited exposure to practice problems requiring higher-order reasoning. Students in the moderate category continued to experience difficulties in interpreting analytical results, making predictions, and formulating appropriate final decisions. In contrast, students in the high numeracy category were able to identify and interpret relevant information, develop problem-solving strategies through mathematical modeling, and formulate appropriate decisions based on their analyses. Based on these findings, several recommendations are proposed:

1. Students in the low numeracy category require targeted instructional support to strengthen foundational mathematical concepts, which are essential for everyday problem solving and further educational development.
2. Teachers are encouraged to provide regular practice with AKM-type problems to strengthen students' numeracy skills and reasoning abilities and to prepare them for subsequent levels of education.
3. Future research should examine AKM-based problems involving more diverse content domains and item characteristics to provide a broader description of students' numeracy skills.

CRediT authorship contribution statement

Aprilia Putri Azzahra: Conceptualization, methodology, investigation, data collection and curation, data analysis, visualization, and writing original draft. Ratih Handayani: Supervision, validation, methodological refinement, and writing review and editing.

Declaration of Competing Interest

The authors declare that they have no known financial interests or personal relationships that could have influenced or could be perceived to have influenced the research findings reported in this article.

Data availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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