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Mathematical Numeracy Literacy Ability of High School Students in Solving Math Problems

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ABSTRACT

As the low mathematical connection problem shows, students are unable to make mathematical connections on their own. Thus, the ability to make mathematical connections is very necessary for training students. This study aims to describe students' mathematical numeracy literacy skills using AKM questions with adapted PISA standards and the difficulties faced by students in solving the given questions. The subjects of this study were grade XI students of SMA Wachid Hasyim 2 Taman Sidoarjo who were selected in one class with a total of 28 students. The type of research used in this study is Mixed Methods Research. The techniques used in this study are test techniques to determine students' ability to solve math numeracy literacy problems, questionnaire techniques to find out students' difficulties, and interviews for in-depth examinations. From the results of the study, it was found that level 1 and 2 category questions were very good, students were able to provide explanations in the form of mathematics and use simple procedures to solve problems. In level 3 and 4 category questions are sufficient, students are still able even though they are not optimal in understanding concepts, representing, and designing solving strategies. On level 5 question, the category is less. This is because students are less able to represent, reflect, and communicate questions properly and correctly. Level 6 category questions are lacking because students have not been able to apply and master technical mathematical operations, develop new strategies and approaches to deal with new situations, and communicate well. The biggest difficulty faced by students is in analyzing problems, representing, designing solving strategies, accuracy of calculations, and communicating them with argumentation.

Keywords**:** *Literacy, Numeration, Matter level*.

Kemampuan Literasi Numerasi Matematika Siswa SMA Dalam Memecahkan Masalah Matematika

ABSTRAK

Dari permasalahan rendahnya koneksi matematika diketahui bahwa siswa belum mampu membuat koneksi matematika secara mandiri. Oleh karena itu, kemampuan koneksi matematika sangat perlu dilatihkan kepada siswa. Penelitian ini bertujuan untuk mendeskripsikan kemampuan literasi numerasi matematis siswa menggunakan soal-soal AKM dengan standar PISA yang disesuaikan dan kesulitan yang dihadapi siswa dalam menyelesaikan soal-soal yang diberikan. Subjek penelitian ini adalah siswa kelas XI SMA Wachid Hasyim 2 Taman Sidoarjo yang dipilih dalam satu kelas dengan total 28 siswa.

Jenis penelitian yang digunakan dalam penelitian ini adalah penelitian metode campuran. Teknik yang digunakan dalam penelitian ini adalah teknik tes untuk mengetahui kemampuan siswa dalam memecahkan masalah literasi numerasi matematika, teknik angket untuk mengetahui kesulitan siswa dan wawancara untuk ujian mendalam. Dari hasil penelitian didapatkan bahwa soal-soal kategori level 1 dan 2 sangat baik, siswa mampu memberikan penjelasan berupa matematika dan menggunakan prosedur sederhana untuk menyelesaikan masalah. Pada soal kategori level 3 dan 4 sudah cukup, siswa tetap mampu walaupun belum optimal dalam memahami konsep, mewakili, merancang strategi pemecatan. Pada pertanyaan level 5, kategorinya kurang. Hal ini dikarenakan siswa kurang mampu mewakili, merefleksikan dan mengkomunikasikan pertanyaan dengan baik dan benar. Pertanyaan kategori Level 6 kurang karena siswa belum mampu menerapkan dan menguasai operasi matematika teknis, mengembangkan strategi dan pendekatan baru untuk menghadapi situasi baru, berkomunikasi dengan baik. Kesulitan terbesar yang dihadapi siswa adalah dalam menganalisis masalah, mewakili, merancang strategi penyelesaian, ketepatan perhitungan dan mengkomunikasikannya dengan argumentasi.

Kata Kunci**:** *Tingkat Literasi, Berhitung, Materi*.

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1. Introduction

Mathematics has been taught at all levels of education, from the lowest education to the highest. Based on this, mathematic learning at all levels of education is expected to be able to improve the ability of students. Hans Freudenthal suggests that "Mathematics is a form of human activity". The statement suggests that Freudenthal does not place mathematics as a finished product, but rather as a form of activity or process (Afandi, 2018).

In line with the National Council of Teacher Mathematics (NCTM), students are expected to have, such as problem-solving, reasoning, proof, connections, communication, and representation (Nurani & Maula, 2020). This means that in learning mathematics, a reasoning process is needed to solve problems. Problems that are intended to be solved are problems in everyday life, so they require mathematical literacy skills. The ability mathematical connection of students in various.

Schools in Indonesia is still relatively low and moderate. This is based on several research results which show that students have low mathematical connection skills and still have difficulty connecting mathematical concepts (Akınoğlu & Tandoğan, 2007). The results of the 2022 PISA survey also support this, showing that mathematics achievement in Indonesia at the junior high and high school levels continues to be low, with Indonesia ranked 68 out of 81 countries with a score of 371 (Balestra & Tonkin, 2018). PISA data shows that, especially in Indonesia, mathematics learning emphasizes basic skills and the application of mathematics in everyday life, automatic thinking, and automatic communication.

The problem of low mathematical connections above shows that students are not yet able to make mathematical connections independently. This is in line with the opinion of Hasbi et al. (2019) that students are not always able to connect mathematical ideas because this greatly affects how teachers teach students to make connections between their knowledge of

mathematics with other disciplines and with the real world. Therefore, students need to learn to make connections.

As mentioned above, it can be concluded that students are not yet automatically able to associate mathematical concepts with things they do every day. Therefore, it is important for mathematics learning in the classroom to associate concepts with things they do every day (Istiroha, 2023). The realistic mathematics education approach is a mathematics learning approach that focuses on how students use mathematics in everyday life and improve their logical reasoning skills. Therefore, this approach is appropriate for training students' mathematical connection skills.

The description above of the realistic mathematics education approach is a learning method that can be used to improve students' mathematical connection skills. Because it uses contextual problems as a starting point for learning, the realistic mathematics education approach is appropriate and suitable for students.

Realistic Mathematics Education (RME), is an approach to mathematics learning developed by a group of mathematicians at Utrecht University in the Netherlands (Jupri & Drijvers, 2016). Based on Freudenthal's idea that "mathematics is a human activity" (Jupri & Drijvers, 2016). This approach describes mathematical activities as problem-solving, problem-finding, and organizing subject matter (Trisnawati & Waziana, 2018). Organization and mathematics are the main tasks. This method does not emphasize passivity but emphasizes student activity. The intended mathematical activity is to rediscover mathematical concepts and ideas by looking at the real world with the help of teachers. Mention that Gravemeijer (Gravemeijer & Cobb, 2006) formulated three principles of RME: (1) guided reinvention and progressive, (2) didactical phenomenology, and (3) self-developed models.

According to the experts above, the RME (Realistic Mathematics Education) Approach is a learning approach that is centered on re-creation and focuses on things that are real for students (reality) or problems that exist in the environment with the following characteristics: (1) using problems contextually, (2) using models, (3) using student contributions, (4) interactive and (5) intertwinement (Elwijaya et al., 2021). Students who study mathematics must have the ability to connect mathematics (Masitoh, 2018). This is by the NCTM statement that explain the mathematical competencies that students are expected to have, such as problem-solving, reasoning, proof, connections, communication, and representation (Garofalo et al., 2000).

The definition of "mathematical connectedness" is the relationship between mathematics itself, with other fields of study, with its applications, and with real problems that students face through mathematical modeling (Rifqi, 2019). According to Coxford (1995), "the ability to connect conceptual and procedural knowledge, use mathematics in life activities, and make connections between topics is known as mathematical connection skills". Students' ability to connect mathematics consists of: (1) understand representations related to the same topic; (2) connect procedures in the same representation with procedures in the same topic; and (3) use and appreciate the relationship between mathematics and other fields (Ida & Sinaga, 2014)

NCTM (2000) describes the standard process of ability mathematical connection in teaching as follows: (1) recognize and use relationships between mathematical concepts, (2) understand how concepts relate to each other and form comprehensive relationships, (3) recognize and apply mathematical concepts in contexts outside mathematics.

Based on the problems described, the objectives of this study are to describe students' mathematical numeracy literacy skills using AKM questions with adapted PISA standards and the difficulties students face in solving the given questions. There is a difference between this study and previous studies, namely combining literacy and numeracy because no previous research has examined it.

2. Research Method

The type of research used in this study is mixed methods. This approach is more suitable for determining students' mathematical numeracy literacy skills in solving mathematical problems designed based on PISA standards. Mixed methods research is used because qualitative and quantitative methods can never be used simultaneously. This is because the two methods have different paradigms and are mutually exclusive (Willems et al., 1985).

This study focuses on only one phenomenon, namely the mathematical numeracy literacy ability of students on a small scale with the most superior scores after the test. This ablity were analyzed based on how to solve PISA standard AKM questions using scoring guidelines and questionnaire sheets that aim to find out the difficulty of solving each question followed by interviews related to the steps in solving PISA questions to get maximum results. The subjects in this study are 28 students grade XI of SMA Wachid Hasyim 2 Taman Sidoarjo. Next, researchers selected 5 people who excelled in mathematical skills. It aims to get results that are in line with the expectations of researchers.

The test instrument is prepared to determine students' mathematical numeracy literacy skills based on levels or levels in PISA. The level of mathematical ability according to PISA is presented in Table 1.

Table 1. Levels of Mathematical Ability According to PISA

Level	**Ability Descriptive**
1	Able to use knowledge to solve routine problems and explicit situations in accordance with the stimuli given
2	Able to interpret and recognize situations in contexts that require drawing conclusions directly
3	Able to carry out procedures well, including procedures that require sequential decisions and select and implement simple problem-solving strategies.
4	Able to select and integrate different representations, including symbolic and relate them to real-world situations.
5	Able to develop and work with models for complex situations, identify constraints and perform guesses, and evaluate strategies to solve complex problems associated with these models.
6	Able to use reasoning in solving mathematical problems, able to generalize, formulate and communicate the results of their findings

Table 1 explains that the questions developed by PISA for the assessment of mathematical numeracy literacy consist of six levels. Mathematical literacy questions at levels 1 and 2 are included in the low-scale group that measures reproductive competence and are arranged based on a context that is quite familiar to students with simple mathematical operations. Mathematical numeracy literacy questions at levels 3 and 4 are included in the medium-scale group that measures connection competence and require interpretation from students because the given situation is unknown or has never been experienced before. The level 5 and 6 math numeracy literacy questions include high-scale questions that measure reflection competence (Rifqi, 2019). This study uses descriptive qualitative data analysis techniques consisting of steps such as data reduction, data presentation, and drawing conclusions. Next, the students' exam results were analyzed based on the assessment score criteria in Table 2.

Table 2. PISA Assessment Standards Based on Process

Process	**Score Percentage**
Model the problem into a mathematical form	25%
Apply mathematical concepts, facts, procedures and reasoning	50%
Interpret, apply and evaluate the results obtained	25%
Total	100%

The next data analysis is to look at students' mathematical numeracy literacy skills based on the results of the tests that have been given referring to the ability criteria (Arikunto, 2009).

3. Results and Discussion

3.1 Results

Table 4 presented the results of the achievement category based on the percentage score of each question level.

Table 4. Results of achievement categories based on the percentage score of each question level

Question Number	Question Level	Number of Students who answered correctly	Average	Category
1	1	23	82%	Very Good
2	2	23	82%	Very Good
3	3	18	64%	Enough
4	4	16	57%	Enough
5	5	12	43%	Less
6	6	10	36%	Less than Once

Questionnaire data is given to each student with the aim of describing difficulties during the test. The following will explain the data from the questionnaire results about the difficulties of students in each question.

This level 1 question does not require high reasoning so that almost all students, namely as many as 23 students or 82%, can answer correctly and the rest answer incorrectly. This level 2 question basically does not require high reasoning, and the results are almost the same as level 1, that is, there are only 5 students, or as many as 18% who did not manage to answer correctly. This level 3 question has started to use reasoning but is not yet high and the result is that most of the students, namely as many as 18 students or 64%, are able to answer the question well and the remaining 36% have not been able to solve the question but basically understand the meaning of the question but have not given the appropriate answer. Level 4 questions are the same as in question number 3, namely most students, namely 16 students or 57% can answer correctly and precisely, and other students or as many as 43% do not understand the meaning of the question so it is difficult to convert it into mathematical modeling. Level 5 questions have begun to use high reasoning. At this level of question, only a small percentage of students, namely as many as 12 students or 43%, were able to answer correctly and the remaining 57% could not answer correctly. The biggest difficulty is that they have not been able to turn problems into mathematical models and communicate them well. Level 6 questions with a high level of reasoning, only 10 students or 36% were able to answer correctly and the remaining 18 students, or 64% of students were not able to solve the questions. It is because most students don't understand and can't generalize, formulate and communicate the results of their findings.

After the questionnaire data was obtained, it continued with interviews conducted with 5 students with the highest scores.

In this level 1 question, the five students of their interview subjects managed to answer the questions correctly and structured. Here are the results of one of the interviews for question number 1.

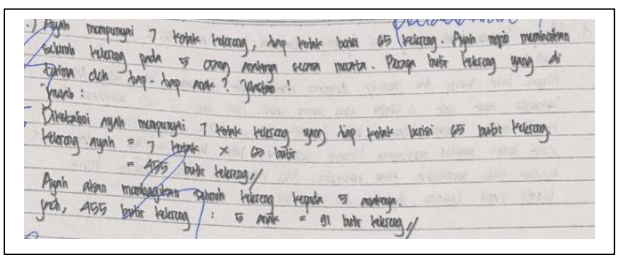

Figure 1. Sample Answer Number 1

For level 2 questions, the five interview subject students stated that question number 2 or the question at level 2 is not too difficult to do, it's just that it requires accuracy in reading the questions so that they can know how to solve the questions. Here are the results of one of the interviews for question number 2.

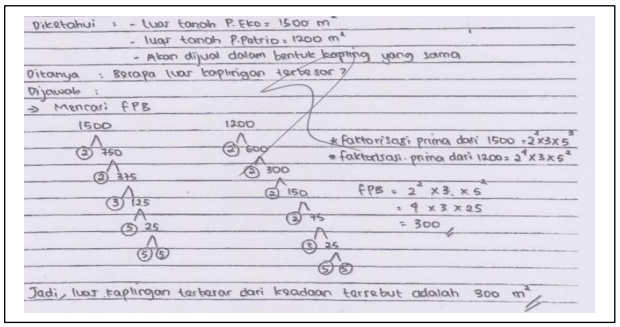

Figure 2. Sample Answer Number 2

In question number 3 or level 3, 3 students think that the question is not too difficult, but the other 2 students think that it requires foresight in calculating to get the right answer. Here are the results of one of the interviews for question number 3.

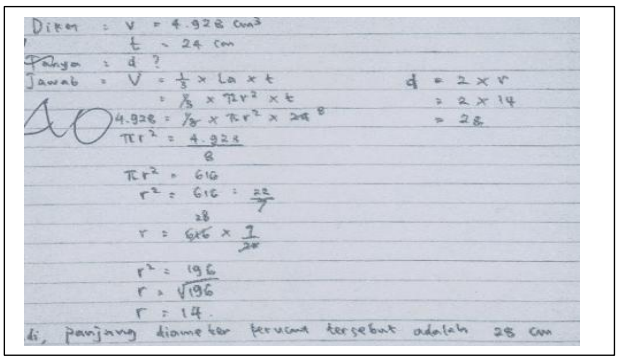

Figure 3. Sample Answer Number 3

For this level 4 question, all students who think that it requires reasoning to solve the problem because the problem is a combination of the area, building space, and comparison, so it requires patience to do it. Here are the results of one of the interviews for question number 4.

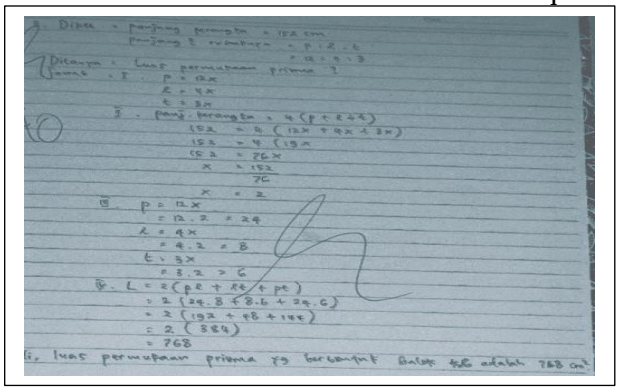

Figure 4. Sample Answer Number 4

In this question at level 5, the five subjects argued that they should create appropriate mathematical models and illustrations of pictures and remember the formulas that should be used so that the questions could be answered correctly. But of the five subjects, only 4 managed to answer correctly. Here are the results of one of the interviews for question number 5.

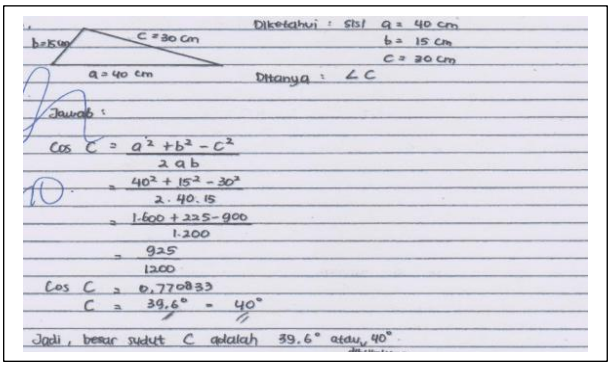

Figure 5. Sample Answer Number 5

In this question at level 5, the five subjects argued that they should create appropriate mathematical models and illustrations of pictures and remember the formulas that should be used so that the questions could be answered correctly. But of the five subjects, only 4 managed to answer correctly. Here are the results of one of the interviews for question number 6.

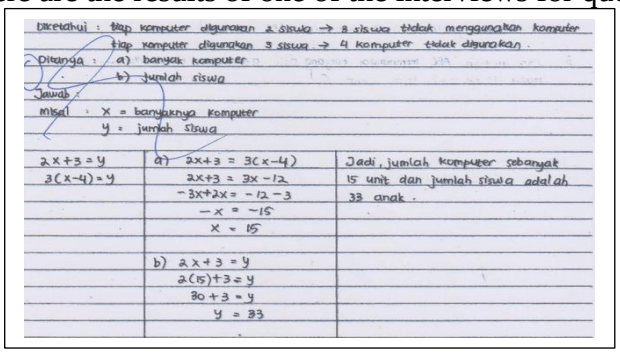

Figure 6. Sample Answer Number 6

3.2 Discussion

On level 1 questions, on average, they get a very good category. The number of students who answered correctly and precisely shows this, as well detailed as many as 23 students with a percentage of 82%. Basically, this problem does not require high reasoning, because all the information needed to answer this question has been presented in the problem, and they have understood the meaning of the problem, then solve it with structured solutions and actions in accordance with the stimuli given to provide the right results and conclusions. In this level 1 question, this shows that students are proficient in mathematics and represent and communicate the questions well.

Similarly, at level 1, for level 2, the category obtained based on the average number of students is good with a percentage of 82%. This level does not require high reasoning, but students must carefully read the questions so that students can interpret and understand situations in context that involve drawing immediate conclusions. Able to collect and use relevant information from one source. They can sort out relevant information from a single source and use a single way of representing. In this level 2 problem it can be concluded that students are able to provide explanations in mathematical form and use basic algorithms, carry out simple procedures or conventions to solve problems involving calculations until students are able to communicate their answers and reasons well.

At level 3, numeracy literacy ability reached a percentage of 64% with sufficient category. Some students are not yet able to perform procedures that require sequential decisions at this level. In addition, students are unable to interpret and use representations from various sources

of information, provide arguments directly, and choose and apply simple approaches to solve problems. At this stage, it is concluded that students can understand problems, understand concepts, represent, design solution strategies, accuracy in calculations, and reasoning, and develop simple communication skills through their results, interpretations, and reasoning.

This level 4 question obtained enough categories with a percentage gain of 57%. At this level, students can still work with models in concrete but complex situations that may involve making assumptions, limitations, or constraints. Students are required to have the ability to select and integrate various representations, including symbolic representations, and to relate them to real-life situations. At this level, students can use their abilities well and put forward reasonable arguments and flexible perspectives according to the situation. Based on students' actions and interpretations, students can provide explanations and arguments at level 4.

For level 5 questions, a percentage of 43% is obtained with less categories. Many students are unable to create mathematical models for complex situations. They can find obstacles, make guesses, and select, compare, and evaluate methods to solve complex problems associated with the model. Higher-order reasoning is required at this level so that students can relate mathematical knowledge and skills to dealing with complex situations. At level 5, it can be concluded that students are less able to do representation and reflection and communicate questions properly and correctly.

In question number 6, it gets the category less once with a percentage result of 36%. This shows that students are not yet able to conceptualize and generalize by utilizing information based on investigation and modeling in complex situations. They are also not yet able to connect various representations and sources of information flexibly, and are not yet able to translate, think, and reason comprehensively about the information. Based on this, in this level 6 problem, it can be concluded that students have not been able to apply and master technical mathematical operations, develop new strategies and approaches to deal with new situations, reflect on their actions, and have not been able to communicate well.

From the explanation above, there are several things that are in accordance with previous research. Siskawati et al., (2024) stated that numeracy literacy skills are the ability to collaborate with mathematical knowledge and understanding effectively in solving problems in various contexts of everyday life by (1) solving problems in the context of everyday life using various numbers and symbols related to basic mathematics, (2) analyzing information presented in various formats, such as graphs, tables, and charts, and so on (3) using interpretations of the results of the analysis to predict and make decisions.

Furthermore, from the results of the questionnaire followed by an interview. Based on the results of these two techniques, there are several difficulties experienced by students while working on questions based on 6 levels. The first is that they have difficulty interpreting the meaning of the questions, because the questions given are HOTS-based story questions, students need more time to really understand the meaning of the questions. The second difficulty is when converting the problem into a mathematical form or mathematical model. According to students, when a mathematical model is wrong then their solution must be wrong so that they make the right mathematical form. The third difficulty is to carry out a structured solution. The solution does not necessarily go straight to the point of the answer but must be detailed because if you calculate it wrong it will make incorrect results. The fourth difficulty is to present the results in a conclusion. If the conclusion is not written down, the results of the solution will not be communicated properly.

This description is in line with the results of research conducted by Mahmud & Pratiwi (2019) which obtained the results of difficulties experienced by students in solving unstructured problems with student work. These difficulties are analyzed resulting in several types of mistakes made by students including misinterpreting the meaning of the question; wrong when performing count operations; and wrong in drawing conclusions.

4. Conclusion

Broadly speaking, students' mathematical numeracy literacy skills are good, only a few students must be able to study harder to understand a problem. In this study there are 6 levels of questions, and each question is represented by one question so that there are a total of 6 questions. For level 1 and 2 questions, they get a very good category. Students can provide mathematical explanations, use basic algorithms, and solve problems that require calculations using simple procedures or conventions, so that they can communicate answers and reasoning well. At level 3 and 4 questions obtained enough categories. At this level students are still able although not maximally, to understand concepts, representing, designing solving strategies, accuracy in calculations and reasoning and communicating them with arguments based on their interpretations and actions. At level 5 questions get less category. This is because students are less able to do representation and reflection and communicate problems properly and correctly. Level 6 is categorized lacking because students are not yet able to communicate well, create new strategies to face new situations, apply and master technical mathematical operations, and reflect on their actions. The biggest difficulty for students is analyzing or understanding the meaning of the problem. This is because students are not used to obtaining story questions based on PISA standards as they are used to getting from teachers. The problems presented are problems that require a high level of reasoning in solving, representing, designing solving strategies, accuracy in calculations and communicating them with argumentation.

Based on the results of the mathematical numeracy literacy ability of High School Students in Solving Math Problems, the researcher provides the following suggestions: Other studies can focus on long-term studies to see the impact of implementing the RME approach on students' mathematical connection abilities over time. This can help teachers ask whether the approach has a lasting impact on students' mathematical thinking abilities. Other researchers can consider developing RME-based learning devices supported by digital technology, such as learning applications or interactive learning media

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