
Students' high order thinking skills in solving mathematical problems in terms of intrapersonal intelligence

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ABSTRACT

High order thinking skills (HOTS) is a person's thought process by memorizing and remembering, but it involves critical thinking, argumentation, and making decisions. The purpose of this study was to find out the profile of the student's HOTS in solving mathematical problems in terms of students' intrapersonal intelligence on rectangular material. This type of research is qualitative descriptive. The subjects consisted of six students from one of the state senior high schools in Yogyakarta, each of 2 students with high, medium, and low intrapersonal intelligence. Data collection techniques using questionnaires, written tests, and interviews. The instrument of this study consisted of an intrapersonal intelligence questionnaire, HOTS-based test questions, and interview guidelines. Data were analyzed consist of reducing, interpretation, and concluding. The results showed that the subject of high intrapersonal intelligence in solving mathematical problems could meet the indicators of HOTS ability, namely the ability to analyze in the sorting category of cognitive processes, organizing, and attributing and the ability to evaluate in checking categories. In contrast, the subject of medium and low intrapersonal intelligence can only meet the indicator of ability to analyze in the sorting categories of the cognitive process.

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1. INTRODUCTION

Higher-Order Thinking Skills (HOTS) is one aspect that needs to be developed, especially in mathematics, to train students to develop thinking and reasoning skills. It is in line with the opinion of Wijayanti & Suhendri (2017) that reasoning ability is a high-level thinking ability or HOTS that must be owned and developed by students. The current HOTS ability is essential for students to support the times. In this global era, competition in the modern world is quite tight, namely competition for human resources. However, the facts show that in the 2015 Program for International Student Assessment (PISA) survey data, the average score of Indonesia's science is 403, literacy is 397, and mathematics is 386. Of the 70 countries globally, Indonesia is ranked 62 (OECD, 2016). The facts are also reinforced from the achievement of the 2018 National Examination (as the last national examination) that the average results for Indonesian subjects are 64.00, English 49.59, Mathematics 43.34, and Science 47.45. The average National Examination

in Mathematics is the lowest compared to the average National Examination results in other subjects.

Along with the times, curriculum changes have become a benchmark for students in the learning process. In the 2013 Curriculum, HOTS becomes one of the roles to improve the quality of students, especially in involving reasoning and analytical thinking patterns to solve problems of daily life. Based on the research of Suryapuspitarini et al. (2018) mathematics questions in the 2013 curriculum were mostly HOTS-type questions. Therefore, the government needs programs for teachers throughout Indonesia to equip students, especially HOTS-based questions, in classroom learning activities. It is hoped that students are used to dealing with HOTS-based questions when students face the National Examination.

In developing one's potential, students' ability is intelligence. Budiyanto et al. (2019) argue that students who have high intrapersonal intelligence will guide themselves to be independent, focus when studying, discipline, love to learn, be responsible, and, more importantly, students will be able to manage their emotions well. So that if it is associated with problem-solving, students need to know and recognize themselves first before analyzing the problems that exist in everyday life. This is in line with Rokhima & Fitriyani (2017) thoughts that solving mathematical problems requires recognizing oneself to measure the extent to which the mathematical problem can be solved. Thus intrapersonal intelligence can guide students to understand and measure their abilities so that they can prepare the material needed in solving mathematical problems. Students with good intrapersonal intelligence will learn material that they have not mastered so that when given the task of solving a problem they will be enthusiastic and challenged to complete it well.

Concerning solving mathematical problems, thinking is an essential aspect of solving problems in everyday life. Alias & Ibrahim (2015) explain that thinking is an abstract activity that usually occurs during a semi-conscious state to solve problems. Thinking is also a natural ability that humans have as a valuable gift from God Almighty (Maulana & Aliska, 2018). The thinking process is divided into three, namely: LOTS (Lower Order Thinking Skills), MOTS (Medium Order Thinking Skills), and HOTS (Higher Order Thinking Skills). The research topic that will be used as the main focus is the ability of HOTS.

HOTS is a thought process, not just memorizing and relaying general information (Pratama et al., 2015). However, HOTS is part of thinking critically, creatively, arguing, and making decisions, according to Widana (2017). So that students do not only rely on the ability to memorize and remember because it is not enough material to train higher-order thinking skills. Aspects that need to be possessed by students to develop HOTS abilities are contained in the primary foundation, namely Bloom's Taxonomy theory. Bloom's Taxonomy Theory before the revision only contained one dimension, while after the revision, it contained two dimensions (Anderson, 2014). After revision, Arends (2012) explains several cognitive aspects in Bloom's taxonomy, which contains six categories: remember, understand, apply, analyze, evaluate, and create. Of the six cognitive aspects above, those included in the HOTS ability category are analyzed, evaluated, and created. Mathematical problems are non-routine math problems.

Not all math problems are math problems, but math problems are definitely math problems. Based on Bloom's taxonomy, mathematical problems that contain aspects of analysis, evaluation and creation are mathematical problems that require HOTS skills. Thus, not every math problem is a HOTS problem. Students with good intrapersonal intelligence will be able to control themselves to maintain concentration and focus in solving math problems, especially HOTS questions. In addition, positive attitudes such as responsibility, independence, discipline, love of

learning can be present in students with good intrapersonal intelligence. This will help students in solving HOTS questions.

Based on the description above, the purpose of this study was to determine the extent of the HOTS ability possessed by middle school students in solving mathematical problems in terms of students' intrapersonal intelligence. It is hoped that the results of this study can be used as input for mathematics educators in junior high schools as well as future researchers who are researching this field of study.

2. METHOD

This type of research is descriptive qualitative research. The research was conducted at one of the State Middle Schools in Yogyakarta with class VIII participants in even semesters. The research subjects taken in this study were six students. Each consisted of 2 subjects based on high, medium, and low levels of intrapersonal intelligence—taking research subjects using a purposive sampling technique. Data collection techniques using questionnaires, written tests, and interviews. The auxiliary instruments in this study were the intrapersonal intelligence questionnaire and the HOTS Question Test. The interview technique used in this study is an unstructured interview.

However, this study only uses problem-solving questions to analyze and evaluate because these indicators already include higher-order thinking skills or HOTS. Fisher explains (Apino & Retnawati, 2017) that the classification of cognitive processes of analyzing, synthesizing, and evaluating in Bloom's taxonomy belongs to the HOTS category, while the cognitive processes of remembering and understanding and applying are included in the LOTS category. The indicator of HOTS problem was explained as follows:

1. Analyze: divide / involve separating material into smaller parts and determine the relationship between known parts.
2. Evaluate: make decisions/assessments based on standard criteria such as quality, efficiency, effectiveness, and consistency.

In this study used one HOTS's problem with the home context. Student asked to analyze and give a reason the number of roof tile to cover the roof.

Data retrieval of the intrapersonal intelligence questionnaire results was obtained through a scale with a total of 40 statements and given to 184 students as respondents. Each statement is provided with four answer choices, namely Strongly Not Appropriate, Not Appropriate, Appropriate, and Very Appropriate, with a score sequence of 1-4. The categories levels of intrapersonal intelligence were high (score $\geq 135,16$), medium ($113,92 \leq \text{score} < 135,16$), and low (score $< 113,92$). The data analysis technique uses a descriptive analysis of the Miles and Huberman model (Miles & Huberman, 1994), including data reduction, data presentation, and conclusions.

3. RESULTS AND DISCUSSION

Based on the intrapersonal intelligence criteria, it can be seen that the highest possible score is $4 \times 4 = 160$, and the lowest possible score is $2 \times 40 = 80$. Based on the intrapersonal questionnaire results, it was found that the identification of the results of the student intrapersonal intelligence questionnaire in the high category there are 24 students, the medium type 132 students, and the low type 28 students. The percentage the number students in each category intrapersonal intelligent is presented in Figure 1 below. So it can be concluded that the intrapersonal intelligence

of class VIII students in one of the Middle schools in Yogyakarta is mainly in the medium category.

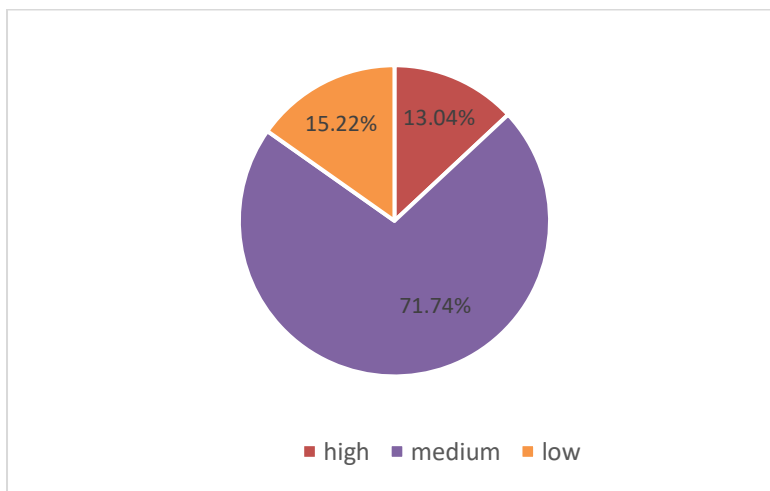


Figure 1. Percentage of number students intrapersonal intelligence

After obtaining the intrapersonal intelligence questionnaire results, the researchers focused on 6 research subjects with 2 subjects each based on high, medium, and low levels of intrapersonal intelligence. The following are the results of research from the six research subjects:

3.1. Subjects with High Intrapersonal Intelligence

The HOTS test results and the results of interviews on subjects with high intrapersonal intelligence in solving mathematical problems show that the subjects can analyze well. It is proven in the cognitive process of distinguishing (sorting), the subject is able to find out the pieces of information contained in the question, namely writing down the length of the roof of the house is 12 m, the width is 6 m, and each m² requires five rooftiles. The Figure 2 are the results of the answers to high intrapersonal intelligence subjects.

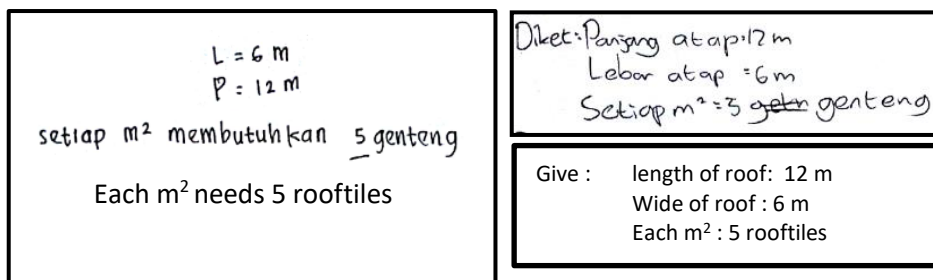


Figure 2. The Sorting Process of High Intrapersonal Intelligence Subjects

In addition, the subject can analyze known relationships with ideas. It is proven that subjects with high intrapersonal intelligence determine how to solve their ideas. Table 1 follows excerpts from interviews with subjects with high intrapersonal intelligence.

Table 1. Interview snippet Subject High Intrapersonal Intelligence Organizing Stage

P	: Are you sure that's the only information in the question?
ST	: Yes
P	: Why do you say that?
ST	: Because the question has already explained the length of the roof and the width of the roof and each m ² requires 5 tiles.
P	: How do you understand this question?
ST	: In my opinion, first find the roof area first then multiply by the number of tiles per m ² .

In the cognitive process of organizing, the subject can identify the elements and form a coherent structure. It is proven that the subject determines the right way to solve the problem in problem by deciding the roof area first, then multiplied by the number of tiles per m². The subject also knows the material applied to the problem, namely the Polygon material. As in Table 2.

Table 2. Interview snippet Subject High Intrapersonal Intelligence Organizing & Attributing Stage

P	: Try to tell me how to solve the problem
ST	: We have to find the area of the roof. Then each m ² requires how many tiles. So we find the area of the roof and then multiply by 5 tiles. Then we will find out how many tiles are needed to replace the old tiles.
P	: Do you remember anything?
ST	: Given the formula for the area of a rectangle

From the Table 2 above, the subject of high intrapersonal intelligence can also determine the formula (attributing) used to solve the problem in the problem. It is proven that the subject knows the area of the rectangle that will solve the problem in the problem, as in Figure 3.



Figure 3. The Attributing Process of High Intrapersonal Intelligence Subjects

In evaluating activities, the subject can perform calculations or test the consistency of the answers well. It is proven that in the cognitive process of checking the subject carries out calculations based on the mathematical model or formula used to solve the problem. The Figure 4 is a snippet of the answers and interviews of subjects with high intrapersonal intelligence.

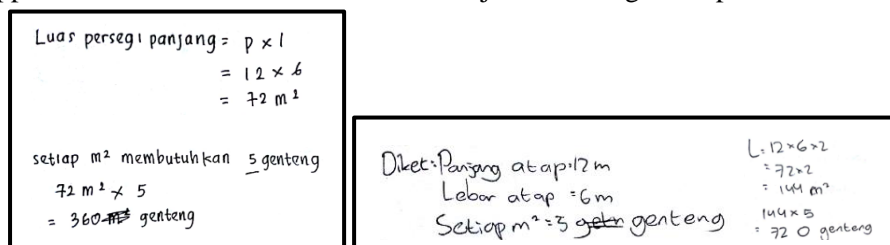


Figure 4. The Checking Process for High Intrapersonal Intelligence Subjects

Table 3. Snippets of answers and interviews Subjects with High Intrapersonal Intelligence Checking Stage

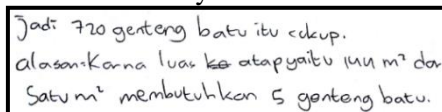
P	: How? Try to put it on the paper
ST	: After knowing that one side of the roof is 72 m ² , that's only one side, then multiply by 2
P	: Just write it on the paper
ST	: Oh, 72 is multiplied by 5 which results in 360 roof tiles. The 360 tiles are multiplied by 2 which results in 720.

The subject also performs activities of checking (checking) the steps and answers again to ensure that the answers are correct and correct so that there are no mistakes in working as shown in Table 3. The following excerpts (Table 4) from interviews with high intrapersonal intelligence subjects in the stage of re-examining answers or results.

Table 4. Snippets of answers and interviews Subjects with High Intrapersonal Intelligence Checking Stage Answer results

P	: Are you sure about this answer?
ST	: Sure
P	: What makes you sure?
ST	: Because I think it's like that
P	: After you do the questions, what do you do?
ST	: Checking again whether what I calculated is correct or not

Subjects with high intrapersonal intelligence also know the conclusions from the correct answers obtained. The following Figure 5 is a summary of the results of the solutions.



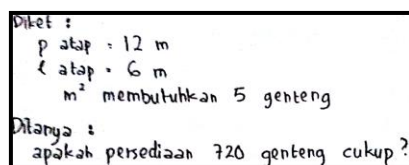
Jadi 720 genteng batu itu cukup.
 alasan: Karena luas ke atap yaitu 144 m² dan
 Satu m² membutuhkan 5 genteng batu.

Figure 5. The process of checking the truth of the results of High Intrapersonal Intelligence Subjects

From some of the explanations above, subjects with high intrapersonal intelligence are able to meet the HOTS ability indicators, namely the ability to analyze in the category of cognitive processes to distinguish (sorting), organize, and attribute as well as the ability to evaluate in the category of examining (checking). The subject can determine the pieces of information in the problem, identify the known elements to form a coherent structure, determine the mathematical model correctly, perform calculations properly according to the mathematical model used, and carry out activities to re-check the mathematical model results to ensure answers.

3.2. Subjects with Medium Intrapersonal Intelligence

The HOTS test results and the results of interviews on subjects with moderate intrapersonal intelligence in solving mathematical problems show that the subject can analyze but is not optimal. It is proven that in the cognitive process of sorting, the subject can determine relevant pieces of information, namely writing down the length of the roof 12 m, the width of the roof 6 m, and each m² requires five tiles. As in the snippet of the results of the following answer as in Figure 6.



Diket :
 p atap = 12 m
 l atap = 6 m
 m² membutuhkan 5 genteng
 Ditanya :
 apakah persediaan 720 genteng cukup?

Figure 6. The Process of Sorting Subjects with Medium Intrapersonal Intelligence

However, in carrying out activities to analyze the relationship between the known parts and the ideas are still lacking. It is proven that the subject made a mistake in associating the elements in the problem with the idea he had, as in the following interview excerpt in Table 5.

Table 5. Snippets of interview results. Subjects with Intrapersonal Intelligence are in the Organizing Stage

P	: Okay, this is related to my research on HOTS questions, what was the first thing you did from that question?
SS	: Calculate the area of the roof first, after that the area of the roof is 72 then multiplied by 5 from every m2 because each m2 requires 5 tiles, so it produces 360.

From the table above, the subject of intrapersonal intelligence forgets that the calculated side of the tile should have two sides and the subject only counts one side. In addition, the results of the identification of the elements in the problem have not yet formed a coherent structure. This is shown from the subject's activities in determining the steps used are not appropriate because in attributing activities, the subject makes an error in determining the formula or mathematical model. As in the snippet of the results of the subject's answer below in Figure 7.

Figure 7. The Attributing Process of Medium Intrapersonal Intelligence Subjects

In evaluating activities, subjects with intrapersonal intelligence are carrying out calculations or testing the consistency of answers based on the mathematical model used by the subject. Still, the answers are incorrect because the model used is not appropriate. When the interview was conducted, the subject did not realize that in doing calculations, the subject made an error in using the formula or mathematical model used, even though the procedure that should have been used was two rectangular areas. Figure 8 shows the following excerpts from the subject's answers:

Figure 8. The Checking Process for Medium Intrapersonal Intelligence Subjects

In addition, the subject has not been maximized when doing activities to re-check the steps and the results of the answers. It is proven that the subject believes that the answer obtained is correct and the subject does not correct the steps of the wrong answer. Table 6 is shown in the following interview excerpt.

Table 6. Snippets of interview results. Subjects with Intrapersonal Intelligence are in the Checking Stage for the Truth of the results

P	: Are you sure like that?
SS	: God willing. Because each cubic meter has 5 tiles, then 36 meters is multiplied by 5, resulting in 180 tiles for the right side and 180 tiles for the left side, so there are 360 tiles in

	total. So that 720 tile is more than enough . So the conclusion is 720 tiles for the right and left sides are more than enough.
P	: Are you sure about this answer?
SS	: Insyaallah

Therefore, subjects with moderate intrapersonal intelligence were only able to meet the indicators of ability to analyze in the category of cognitive processes to distinguish (sorting). The subject is able to determine the pieces of information in the problem. Still, in identifying the elements that do not form a coherent structure, the mathematical model used is not right, testing the consistency of the answer. Still, it is incorrect because the model used is not appropriate, and the answer is also not optimal in checking the steps.

3.3. Subjects with Low Intrapersonal Intelligence

The results of the HOTS test and interview results on subjects with low intrapersonal intelligence in solving mathematical problems show that the subject can determine the relevant information. It is proven that the subject knows the length of the house's roof is 12 m, the width of the roof is 6 m, and each m² requires five tiles. As in Figure 9, following snippet of the subject's answers.

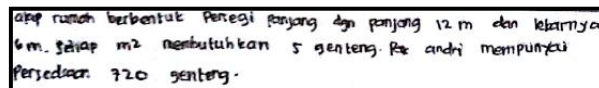


Figure 9. Sorting Process of Low Intrapersonal Intelligence Subjects

However, subjects with low intrapersonal intelligence have not been able to analyze the relationship of the parts known to the subject's ideas. It was proven that when the interview was conducted, the subject was confused in determining the relationship of the known parts of the question. Table 7 below shows from the interview excerpts of researchers with subjects with low intrapersonal intelligence:

Table 7. Snippets of interview results Subjects with Low Intrapersonal Intelligence at Organizing Stage

P	: Okay, do you think the information in the question is related to each other?
SR	: Yes
P	: What's the connection?
SR	: (Thinking)
P	: Are you confused?
SR	: Confused mas
P	: Why are you confused?
SR	: Play around

The subject also has not been able to identify the elements contained in the problem, so it does not form a coherent structure. It is evident that the subject plans problem-solving steps not based on mathematical models and only as long as connecting the elements in the problem. In addition, the subject also did not write down the mathematical model or formula used. As in the snippet of the results of the following low intrapersonal intelligence subjects (Figure 10).

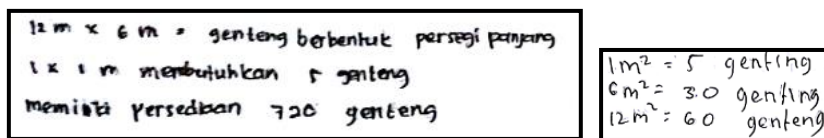


Figure 10. Organizing & Attributing Process of Low Intrapersonal Intelligence Subjects

In evaluating activities, subjects with low intrapersonal intelligence perform calculations but not mathematical models. The subject does not write down the mathematical model or formula used in the answer sheet. The subject also performs calculations only by trial and error as in the following excerpts of the results and interviews (Figure 11).

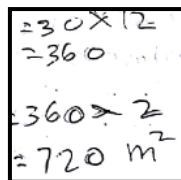


Figure 11. Checking Process for Low Intrapersonal Intelligence Subjects

Table 8. Snippets of interview results Subjects with Low Intrapersonal Intelligence Checking Stage

P	: 12 where did it come from?
SR	: From the length of the roof
P	: 30 from where?
SR	: From the width of the roof multiplied by 5 tiles
P	: Then you didn't use the 60 tiles for the calculation?
SR	: No
P	: Then where did those 2 come from?
SR	: From trial and error (with a smile). From 2 sides

From Table 8 above, the subject also made an error in writing the unit that should be tile, but it was written m^2 . In addition, the subject was less than optimal in checking the steps and results of the answers. It is proven that the subject only matches the results obtained with the questions in the problem without re-checking the calculation steps carried out. As in the snippet of the conclusion of the following answer (Figure 12).

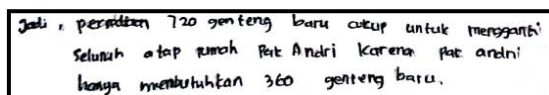


Figure 12. The Checking Process for Low Intrapersonal Intelligence Subjects

Therefore, subjects with low intrapersonal intelligence were only able to meet the indicators of ability to analyze in the category of cognitive processes of sorting. The subject can determine the pieces of information in the problem, but in identifying elements that are known not to form a coherent structure, do not use mathematical models or formulas used, perform calculations without mathematical models, and are not optimal in re-checking the steps and answer results.

This shows that there are differences in the HOTS abilities possessed by subjects with high, medium, and low intrapersonal intelligence in solving HOTS problems. Subjects with high

intrapersonal intelligence are at the capable level, while subjects with moderate and low intrapersonal intelligence are less able. This supports the research of Rokhima and Fitriyani (2018) that the level of students' intrapersonal intelligence can affect metacognitive activity in solving mathematical problems. Students who have high intrapersonal intelligence can perform all metacognitive activities such as planning, implementing, and evaluating the results of the answers. Meanwhile, students who have moderate and low intrapersonal intelligence in carrying out metacognitive activities are not optimal. So, students' level of intrapersonal intelligence greatly affects student activities, especially in solving mathematical problems. This finding have difference with Prayitno's finding (2020) which said that subjects with high intrapersonal intelligence were able to choose and decide on formulas that may be used to solve difficulties, allowing them to finish tasks correctly and in a reasonably short amount of time. Subjects with medium intrapersonal intelligence can accurately apply the formula, but problem solving falls into the standard range. Subjects with low intrapersonal intelligence rate their own problem-solving skills highly, but they frequently choose the wrong solution.

4. CONCLUSION

Students with high intrapersonal intelligence can fulfill the HOTS ability indicators of analyzing in the area of cognitive processes to identify, organize, and attribute and evaluating in the category of checking. Students with moderate intrapersonal intelligence can only fulfill the markers of ability to assess and distinguish cognitive process categories. The subject can determine the pieces of information in the problem, but there are errors in organizing activities, such as identifying elements that do not form a coherent structure, errors in attributing, such as determining mathematical models, testing the consistency of answers but not correct because the model used is not appropriate, and errors in checking the steps and answers. Meanwhile, students with low can only fulfill the markers of ability to assess cognitive process categories to discriminate. The subject can determine the pieces of information in the problem, but not in organizing activities, such as identifying elements that are known not to form a coherent structure, not attributing activities, such as determining the mathematical model or formula used, performing calculations without a mathematical model, and not optimal in re-checking the steps and the answers.

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