The Process of Thinking among Junior High School Students in Solving HOTS Question

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Article Info	ABSTRACT
	Higher order thinking skills (HOTS) is one of the important aspect of teaching and learning mathematics. By using HOTS, student will be able to acquire a deep understand of mathematical concepts and can be applied in real life. Students ability to develop the capacity of the HOTS is closely related with thinking processes while solving mathematics problems. This research focused, at describing the thinking process of students in solving mathematical problem involving HOTS problem. The method used is a qualitative method and case study design, the data collected through mathematics tests and interviews. There are 3 students selected as participant Data analysis techniques are descriptive qualitative, analysis according to the model proposed by Miles and Huberman, namely data reduction, data presentation and conclusion. The result of the study showed that the thinking skills of student with high math ability, medium math ability, and low math ability in solving Hots problem are different. The student who has high math ability is able to create meaning, make opinion and can conclude, while the student who has medium math ability is able to create meaning, make opinion but cannot conclude, and the student who has low math ability is not able to create meaning and cannot conclude.

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1. INTRODUCTION

Mathematics ability of junior high school students is still at a low level. According to the report of national exam, the average math score was 5.78 (scale 10.0), while the report of national exam for junior high school students in Makassar is 4.68. This score indicates that the mathematical ability of students in Makassar is still at a low level [1]. Students' low math ability in the assessment of the national examination showed that some problemsexist in the process of teaching and learning mathematics in the classroom. The teachers need to diversify activities in the classroom through the use of various teaching methods to encourage and develop thinking skills in students [2]. Thinking skills is an important aspect for students that can help the brain activity of students in understanding and remembering the lesson. With this skill, students are able to use knowledge in solving everyday problems [3]. They not only need thinking skills that involve problem solving but also involve finding the problem and exploration of new opportunities as well as generating new ideas.

Thinking is an activity in which the mind is used to make decisions using information to find meaning, to make judgments, solve problems or make decisions on a problem based on the information and experience existing in everyday life. Thinking is a dynamic process that can be described by the process. It is essentially a process of thinking where there are three steps, namely the creation of meaning, forming an opinion and conclusion [4].

Students' thinking ability in junior high school can be developed through learning activities and teaching mathematics. This is supported by the purpose of learning mathematics that had been declared by the Indonesian National Education Ministry that the purposes of learning mathematics are (1) to think and reason to conclude, (2) develop creative activities that involve imagination, intuition, and the discovery, originally, curiosity, conjecture and supposition and dare to try, (3) develop problem-solving skills, (4) develop the ability to convey information and to state the argument [5].

The implementation of teaching and learning mathematics has not been able to develop students' thinking skills; the process of teaching and learning mathematics in Indonesia is still focused on the teacher, not focused on student, so learning in schools involves more memorizing or factual knowledge [6]. It is very much different from the national education goals of developing the ability of students to think critically, think logically, systematically, be objective, honest and disciplined. Therefore, this paper focuseson describing the thinking process of students in solving mathematical problems involving HOTS problem.

2. RESEARCH METHOD

This study used qualitative methods.There are three main objectives for the implementation of qualitative analysis, which are 1) included a variety of data collection and more to form a concise and easy to understand, 2) establish a clear link between the objectives of the study and a summary of the findings obtained from the raw data set and to ensure that the relationship is capable of supporting the objectives of the study and 3) build a model or theory related to the review process in studies undertaken [7].

There are three different levels of student ability in mathematics following this study, namely students with high math ability (ANS), students with moderate math ability (ALY) and students low math ability (NRS). The criteria are based on the study participants, including (1) The result of mathematics final exam, (2) student has been learned material Pythagoras and (3) The student is able to communicate verbally. Data collection instrument used in the study of mathematics problem based on HOT Skill is interview session with students. Data analysis method that will be carried out in this research is descriptive qualitative analysis according to the model proposed by Miles and Huberman, namely data reduction, data presentation and conclusion [8].

3. RESULTS AND ANALYSIS

This study was conducted to three students who have different mathematics abilities. Each student is given a question of mathematics based on HOTS skill, and then their answers were analyzed referring to the indicators below:

Table 1. Indicator of Thinking Process

Thinking Process		
Creation of meaning(C1)	forming an opinion (C2)	Conclution(C3)
The student is able to explain the information in question as determining elements / components that are known in the question and the component in question. (C1.1)	The student is able to write down mathematics concepts related to problems.(C2.1)	The student can conclude towards the solution of problems. (C3.1)
The student is less able to explain the information in question as determining elements / components that are known in the question and the component in question. (C1.2)	The student is less able to write down mathematics concepts related to problems. (C2.2)	Less complete in the conclusion to solve the problem. (C3.2)
The student cannot explain the information in question as determining elements / components that are known in the question and the component in question. (C1.3)	The student cannot to write down mathematics concepts related to problems.(C2.3)	Incomplete in the conclusions of the resolution of problems. (C.3.3)

In this study, all students were given a math question at non-routine level of application, the HOT Skill component that is expected to be done by the students is the ability to use the concept of Pythagoras in a new situation. The question that was given to students is *"Syam will cross the river which has a width of 12 m, after arriving across the river,Syam drifts as far as 5m. Determine the distance of the current across the river."*

3.1. Mathematics Test
3.1.1 Subject ANS

Subject ANS is a student has higher mathematics ability according to the final exam in the last semester. The result of mathematics test by subject ANS:

Figure 1. ANS Answer Sheet

Figure 1 above shows that Subject ANS can find all the information in the question, and then write the information in mathematic formula, like the student is able to write the information into the right triangle (C1.1). Then, for the next step, the student makes the opinion, ANS determines that the problem is related to Pythagoras formula until she wrote Pythagoras concept and correlate with questions. (C2.1), and lastly, the student concluded that the distance in which Syam crosses the river is 13 meters (C3.1)

3.1.2 Subject ALY

Subject ALY is where a student has moderate mathematics ability according to last semester's final exam last semester. Here are the results of mathematics test by subject ALY:

Figure 2. ALY Answer Sheet

Figure 2 above showed that subject ALY cannot write all the information in the question (C1.2). Next,in the step of making the opinion, subject ALY determines that the problem is related to Pythagoras

formula but he cannot write Pythagoras formula, (C2.2) until he obtains less accurate answer is 13^2, and then cannot be full concluded (C3.2)

3.1.3 Subject NRS

Subject NRS is where a student has low mathematics ability according to last semester's final exam last semester. The result of mathematics test by subject NRS is:
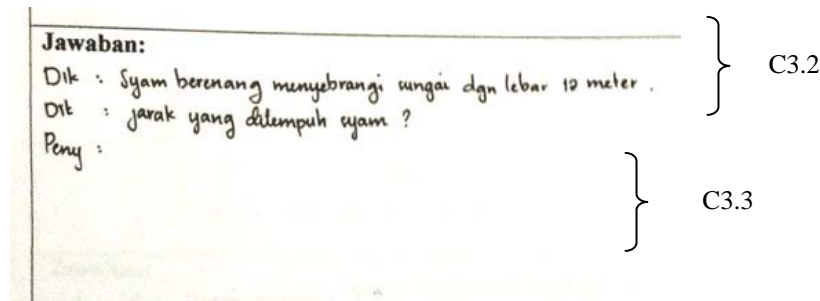

Figure 3. NRS Answer Sheet

Figure 3 above showed that subject NRS cannot write all the information in question (C1.2). Then, in the step of making the opinion, subject NRS cannot determine the ideas/concepts related to the problem in question and so, she is unable to solve the problem. (C2.3). Lastly, ALY was not able to conclude (C3.3)

3.2. Interview Analysis

Interviews were conducted in a systematic procedure to describe the process of thinking while solving math problems. In this study, researchers have applied the suggested procedure by Boyce and Neale to design the interview guidelines. Process of interview is divided into three main sections: 1) the introduction, which is intended to determine the identity of students, 2) the question part, in this section researchers typically ask about student responses while solving challenging math questions, in part, researchers also discover the process of thinking, 3) Conclusion, is the final part of the interview to be conducted. Researchers also raise other questions depending on the answers given by the students [9].

3.2.1 Subject ANS

According to the result written test by ANS, it shows that she was able to answer the questions completely. She has been making the meaning of information available on the question. Subject ANS is able to write the Pythagoras concept, and then she used the Pythagoras concept to solve the problem. The results of interviews with researchers and subject ANS:

R   :   If this, Pythagorean. What is the question asking for?
S   :   Hypotenuse
R   :   How did know what the hypotenuse is?
S   :   Because, this is width… 12 m
R   :   Width for?
S   :   Based on width for the river

In transcription above, the ANS recognizes that this question is a Pythagoras, and then she tried to draw a right triangle, with the width of the river 12 meters high and hypotenuse is the distance Of the current across the river by Syam. ANS is writing the Pythagorean formulas and making opinion associated with the question. The following is the interview transcripts:

R   :   Here (a,b, and c)… how do you know?
S   :   a is based, b is high, and c is hypotenuse in the
        question is hypotenuse so $c^2 = a^2 + b^2$
R   :   Emm
S   :   So… here adjusted a…b…c…

The transcription indicates that the ANS student can determine his opinion on the problem in question with the Pythagorean theory. Next, mathematical operations were performed so as to obtain a

conclusion that Syam swims as far as 13 m to cross the river. This can be seen in the following transcription below:

R   :   Mmm…, so the next step?
S   : $c^2 = a^2 + b^2$
          $c^2 = 12^2 + 5^2$
          $c^2 = 144 + 25$
          $c^2 = 169$
          $c = 13$
R   :   What is the conclusion?
S   :   Hypotenuse is 13 m, or Syam crossed the river
          as far as 13 m

3.2.2 Subject ALY

On this question, ALY also successfully answered this question even though there are still some mistakes. She has been making the meaning of information available on the question but she cannot identify the formula name to solve the problem. Refer to the interview transcripts below:

R   :   Can you explain, what is the information you will
          take from this question?
S   :   Pythagorean, generally if the question like that…

In the transcription above, ALY cannot provide some argument for determining the characteristics of the Pythagorean questions, she begins writing down to identify what she knows. The following is the interview transcript:

R   :   Can you draw again?
S   :   So…, this is a triangle … the Pythagorean
R   :   Where is the triangle from?
S   :   From here…
R   :   Are you sure?
S   :   12 is based,…5 is the distance in river

From the transcription above, it seems less convincing that ALY can determine the elements that are in question, so she less understood in collecting the information in question, such as, she said 5m is distance.

3.2.3 Subject NRS

NRS is the student who has low math ability, he was not able to answer this question because he was not able to understand all the information in question, and he does not have prior knowledge about the relationship between the concepts of Pythagoras with the problem in question, following the transcription students with researchers.

R   :   Do you understand the question?
S   :   No….
R   :   Ah… why don'tyou know?
S   :   ….(feel confused)

In the transcription above, Student NRS said that he did not understand the question, so he is not able to make meaning. Then, the subject NRS said given that it cannot form a notion. The subsequent discussions helped researchers trying to determine the opinion of Adar NRS / mathematical ideas and concepts that can be used in solving this question, following the results of interviews with researchers NRS subject:

R   :   The next question, how to find this?
S   :   What..? Repeat please…!
R   :   How to find (hypotenuse)?
S   :   I don't know
R   :   Here is the hypotenuse, this is a triangle, this means that is
          Pythagorean

$$S \quad : \quad \text{Oww.... here } c^2 = a.b$$

The interview transcription above showed that the subject NRS cannot set opinions related to this question, so that he cannot determine the answers and make conclusions.

4.   DISCUSSION

The objective of the research in this paper is to describe the process of thinking while solving HOTS questions. Thinking is a dynamic process that can be described by the process and the implementation. The process of thinking is a process that consists of the receipt of internal and external information as well as management, storage and recall of information from memory. The process of thinking is the process of collecting information, storing, creating opinion, conducting operations and making inferences or conclusions [10].

The steps of the process of thinking are:(1) the creation of meaning, namely by analyzing the characteristics of a number of similar objects, and differentiate those features (2) set of the opinion, that puts the relationship between two or more understanding and (3) making conclusion or inference that is a result of the act of understanding to form a new opinion based on the existing opinions [11].

4.1. The student with High math ability

The student who has high ability in mathematics is the student who gets a score around 90 – 100 in mathematics final exam. ANS is a student who gets a score of 95. According to data analysis and the result of interviews, the process of thinking while solving math questions HOTS isdescribed in the flowchart below:
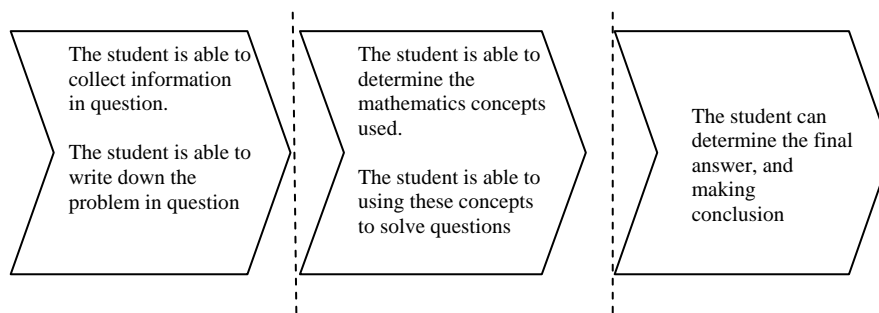
The student is able to collect information in question.

The student is able to write down the problem in question

The student is able to determine the mathematics concepts used.

The student is able to using these concepts to solve questions

The student can determine the final answer, and making conclusion

Figure 4. High ability of student's thinking process

Figure 4 above showed that the student who has high math ability is able to create meaning like the student is able to collect information in question, the next step in making of opinion the student is able to determine the mathematics concept and using these concept to solve questions. Lastly the student can determine the final answer and making conclusion.

4.2. The student with medium math ability

ALY is the student who has the medium math ability according to the score of mathematics in final exam. She gets a mathscore of 85. According to the data analysis and the result of interviews in this study, the process of thinking while solving math questions based-HOTS is described in the flowchart below:

Creation of meaning

Making of opinion

Conclusions

The student is less able to collect information in the question.

The student writes down the problem in question but do not complete it

The student is less able to determine the mathematics concepts used.

The student is able to use these concepts to solve questions.

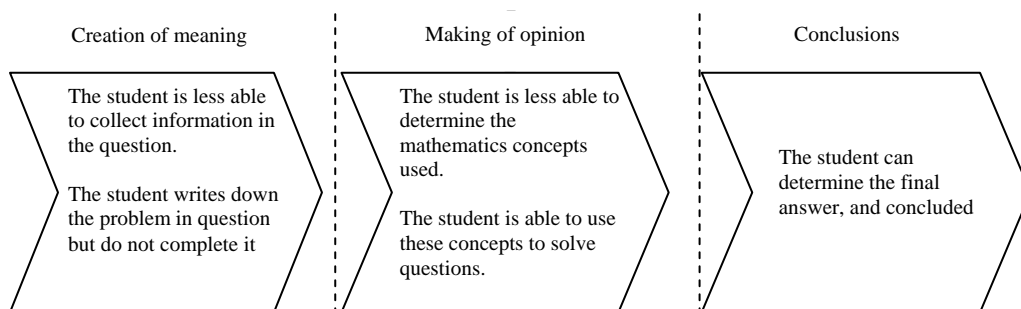The student can determine the final answer, and concluded

Figure 5. Medium ability of student thinking process

Figure 5 showed that the student who has medium math ability is the student is less able to collect information in question, the next step in making of opinion the student is less able to determine the mathematics concept used and the student can determine the final answer and making conclusion.

4.3. The student with low math ability

NRS is the student who has low math ability, where she got a score of less than 75 points in the final examination. According to the data analysis and the result of interviews in this study, the process of thinking while solving math questions based-HOTS is described in the flowchart below:

Creation of meaning   Making of opinion   Conclusions

The student is not able to collect information in question

The student write down the problem in question but do not complete the problem in question

The student is not able to determine the mathematics concepts used

The student is not able to use these concepts to solve questions

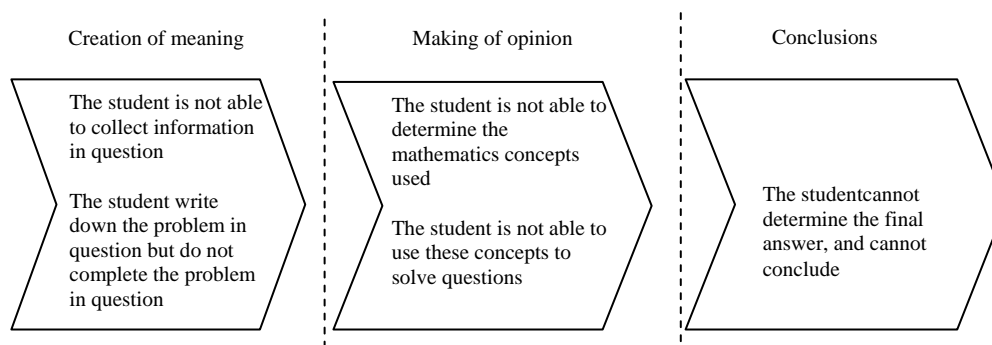The studentcannot determine the final answer, and cannot conclude

Figure 6. Low ability of student's thinking process

Figure 6 above showed that the student who has low math ability is not able to create of meaning, the student is not able to collect information in question. The next step in making of opinion the student is not able to determine the mathematics concept and the student is not able to use these concepts to solve questions. Lastly the student cannot determine the final answer and cannot conclude.

5. CONCLUSION

The thinking skills of student with high math ability, medium math ability, and low math ability in solving Hots problem are different. The student who has high math ability is able to create meaning, make opinion and can conclude, while the student who has medium math ability is able to create meaning, make opinion but cannot conclude, and the student who has low math ability is not able to create meaning and cannot conclude.

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