Mathematical problem solving tasks in the form of high order thinking skill

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Abstract. This article describes mathematical problem solving task which is categorized in form of high order thinking skills. The study used descriptive qualitative as research methodology and involved junior high school students in Palembang city as research subject. Data collections consist of students’ worksheet, observation, and interview. The result showed that mathematical problem solving tasks categorized into form of high order thinking skill were mathematical tasks that contain commands to do analysis, evaluation, or creativity. A question that requires students to recognize elements needed and their relationship is kind of analysis type. Furthermore, a question containing command to accept or to reject a statement based on their analysis is included into evaluation type. Moreover, if it provokes students to make new structures that have never existed before or to generalize an idea then this is creation type. The classification of mathematical problem solving tasks including HOT problems is based on the top of Bloom's cognitive taxonomy.

1. Introduction

High Order Thinking Skill (HOTS) which includes the ability to think at the level of analyzing, evaluating, and creating ideas is an ability that is very important for the achievement of 21st century competence which consists of the ability to think critically, creatively, collaboratively, and communicatively which is very necessary for the needs of students in solving the problems that they face in everyday life [1,2].

Indonesian student ratings on the PISA results that were still in low level [3,4] show that the Indonesian students’ High Order Thinking Skill (HOTS) is still low in solving High Order Thinking questions [5-8]. The low level of thinking ability of Indonesian students is generally due to students not yet accustomed to solving HOTS questions on learning [8,9]. Based on analysis data from TIMSS 2015 results showed that Indonesian students tend to master routine questions, simple computation, which emphasizes aspects of memory and lacks training in high order thinking skills of students [10]. This fact leads to the lack of problem solving skills of students to solve high difficulty levels of problems because most of the questions given in the lessons only focus on problems with low difficulty levels [11].

The results of research from Sampoerna Foundation shows that the questions of the National Exam only revolve around the level of memorizing the formula, using procedures, and showing a formal understanding [12]. While the other two aspects of making conjecture/ generalize/ prove and solving non-routine problem are not touched at all in the matter of the mathematics National Exam. Though both aspects are the highest level in the cognitive aspect. Some prior studies done by Kamaliyah [13],...
Oktaningrum [8], and Permatasari [14] were also conducted purposing to develop problems like PISA as a form of non-routine mathematical problems Novita also explored primary student's problem-solving ability by doing tasks like pisa's question [15]. However, the limitations of mathematical problem solving task in the form of high order thinking skills are still unclear. Therefore, this research aimed to describe kind of mathematical problem solving tasks in form of high order thinking skill.

2. Method
Qualitative research type descriptive study is chosen as research methodology in this study. It is a kind of study investigating quality of materials, situations, activities or relationship. It emphasizes on describing in detail what really happens in a activity or situation or describing behaviours of people rather than on comparing the effect of treatment [16]. Five steps in qualitative research are 1) Identifying the phenomenon studied, in this study, we would like to describe mathematical problem solving task in the form of high order thinking skills; 2) Identifying research subject in the study, as many as 29 Junior High School students, who aged 14 - 15 years old, were involved; 3) Generalizing hypotheses, we predicted that mathematical problem solving task are also high order thinking problems with some criteria; 4) Collecting and analyzing data – students’ worksheet, observation, and interview are used in getting deep information about what kind of mathematical problem solving task that are also high order thinking problems and data are analyzing descriptively; 5) Interpreting and making conclusion, we refer to the criteria of high order thinking problems as a guideline in interpreting and making conclusion [16,17].

3. Results and discussion
3.1. Results
Students were asked to solve mathematical problem solving tasks. There were 3 questions given and students solved those questions in places provided in students worksheet. Those 3 questions are showed in figure 1-3.

![Figure 1](image1.png)

**Figure 1.** The first question.

![Figure 2](image2.png)

**Figure 2.** The second question.

Wahyu and Ridho play marbles with other friends. Wahyu and Ridho each have a number of marbles, 120 and 24. If every day playing, Wahyu always loses while Ridho always wins. The difference between their marbles on day 7 is 40 and the number is 158. Will the number of marbles of Wahyu and Ridho be the same on the 10th day?
A driver got an order from a passenger of the LRT train, when he got an order he was 0.5 km behind the LRT train that drove at 50 km / hour. It is estimated that in the next 4 minutes the LRT train will arrive at the station, because the passenger is in a hurry, the passenger wants the driver to go to the station before the LRT arrives at the station. If the speed of the driver goes 60 km / hour, can the driver get to the station before the LRT train?

Figure 3. The third question.

Those three mathematical problems in figure 1-3 were given to students in a sheet. Then, students worked on the problem without having to do from the first problem. They might work on the problems that they thought it could be solved first.

Figure 4. Students’ work in solving mathematical problem in figure 1.

Figure 5. Students’ work in solving mathematical problem in figure 2.
Figure 4 shows how student determined the length of FG, he started from calculating a quarter of circle circumference. Then, he assumed the length of FE is 6 cm. By using Phytagoras theorem, he got the length of FG. The way how he solved the problem shows that he did not recognize FG as diagonal of square as well as OE. He also was not able to identify OE as circle radius and its relationship with FG.

In figure 5, student solved problem by finding out the number of marbels gotten by Ridho or given by Wahyu per day. Then, he determined the number of Ridho’s marble and Wahyu’s marble after 7 days later.

Figure 6. students’ work in solving mathematical problem in figure 3.

Figure 6 described how student solved driver problem started from determining time required by train dan driver to arrive at the station. He compared velocity of train or driver with the distance of driver and train to get the value of time. However, it is not the intended distance.

3.2. Discussion

The importance of high order thinking skills for students influences the orientation and structure of curriculum in Indonesia so that the Indonesian government enforces the 2013 Curriculum by setting graduation standards that expect graduates who have the ability to think critically, productively, independently, collaboratively and communicatively [18]. The 2013 curriculum emphasizes 21st century competencies which include the ability to think and solve problems through observing, asking, listening, and communicating answers to problems [5,19]. This study describe form of mathematical problem solving questions that full fill criteria of high order thinking problems. The result shows that to provoke students to think in high order level, the problem given should contain instruction to analyze, to evaluate, or to create. This is in line with Krathwohl that high order thinking skill includes the ability to analyze, evaluate, and create which has the following indicators [20].

| Level | Indicator | Description |
|-------|-----------|-------------|
| C4    | Analysis  | Differentiating  
Analyzing incoming information and dividing or structuring information into smaller parts to recognize patterns or relationships  
Organizing  
Recognizing and differentiating the causes and consequences of a complex scenario.  
Attributing  
From the information and factors that exist, students identifying / formulating questions |
Table 1. Cont.

| C5 | Evaluation | • Checking Providing an assessment of solutions, ideas and methodologies using suitable criteria or existing standards to ensure the value of effectiveness or benefits.  
• Critiquing Making hypothesis, criticizing, testing and accepting or rejecting a statement based on predetermined criteria |
| C6 | Creation | • Generalizing an idea or perspective on something  
• Designing a way to solve problems and organizing elements or parts into new structures that have never existed before |

Table 1 contains indicators of high order thinking skills that can be used as references in determining whether the mathematical problem solving tasks is included into HOT problems or not. According to table 1, a mathematical problem solving is categorized into Analysis type if it encourages students to structure information and to recognize patterns or relationship among information given. “Determine the length of FG!” is one example of Analysis question type since students need to recognize elements needed and their relationship to find the length of FG. Mathematical problem solving containing a question such as “Will the number of marbles of Wahyu and Ridho be the same on the 10th day?” was able to provoke students to analyze information and to give their judgment based on their analysis. According the description of high order thinking indicator in table 1, this kind of question is included into Analysis and Evaluation level. However, among those three questions given, there were nothing questions included into Creation type because this type of question asks students to make new structures that have never existed before or to generalize an idea. According to Brookhart higher-order thinking skills (HOTS) are (1) high-level thinking that is at the top of Bloom's cognitive taxonomy, (2) the teaching objectives behind cognitive taxonomy that can equip students to transfer knowledge, (3) able to think means that students are able to apply the knowledge and skills they have developed so far [21,22].

4. Conclusion
Efforts are needed to train students' high order thinking skills, including training them in solving HOT problem. Mathematical problem solving tasks which are categorized as HOT problems have characteristics, namely questions containing commands to analyze, evaluate, or create creativity in the problem solving step.

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