Creating category Higher Order Thinking Skills (HOTS) exercise for high school students

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Abstract. HOTS is an important aspect that must be developed for students in order to solving problems and learning mathematics that is not routine because HOTS requires the ability to think creatively and critically, so the purpose of this research is to develop HOTS questions categories of creating (C6) that are valid and practical and have potential effects towards students’ math literacy. The method of this research is development research with preliminary and formative evaluation stages including self-evaluation, expert reviews, one-to-one, small groups, and field tests. Techniques for collecting data used documents, walkthroughs, interviews, tests, and observations while data analysis uses descriptive. The conclusion from the results of this study is the HOTS exercises creating category (C6) which is valid can be seen from expert review based on content, construct and language assessment. It can be seen from small groups, while the potential effect on students’ literacy skills is quite good. This can be seen from the ability of students to analyze information about exercise, make ideas in designing problem solving and organize elements into new structures that may never exist before.

Keywords: high order thinking skill (HOTS); creating.

1. Introduction

One of the fields of science that has an important role in the development of technology and information is mathematics, in order to face global competition it is expected that everyone can understanding mathematics (mathematical literacy). In the era of globalization, competitive human resources are highly needed so that they can facing the demands of increasingly advanced era [1]. In addition, qualified human resources have the critical, systematic, logical, creative, and willingness to work together effectively [2]. Then human resources who have thoughts that are always generated from educational institutions. While mathematics is one of the most important science in education, because mathematics whose thought process is not limited to the world of education but also applies it in various fields such as population, economics and business, administration, and so on.

Students’ mathematical competencies is no longer concerning the ability to count, but also logical and critical reasoning ability in problem solving. Therefore, teachers are expected to design their own material and contextual exercises as the tools to improve the quality of teaching and learning processes [3]. Education have influence in the quality of human resources, education’s quality begins with learning’s quality as well. At the same time, learning objectives should be precisely arranged to increase the quality of learning [4].

A person who has a high level of thinking ability, can be seen from various aspects, namely ability, critical, creative and problem solving.[5] also explained that critical thinking is one of the high-level
thinking processes that can be used in forming student conceptual systems. Creating creative ideas means creating an unusual thing to resolve the problem. There are some indicators show that someone who has the ability to think creatively, is able to give new ideas, questions, and able to experiment and strategize. While problem solving skills (problem solving) required the ability to think critically and creatively. Bidasari [6] defines that problem-solving ability is a part of the curriculum of mathematics that is very important because in the process of learning and completion, students gain experience using the knowledge and skills they already have to apply to solving problems that are not routine.

One of the government's efforts to develop the ability to think creatively and critically is through HOTS which is applied in the curriculum. Conklin in Arifin [7] explained the characteristics of higher order thinking skills as "encompassing both critical thinking and creative thinking." Therefore, high-level thinking skills are characterized by critical and creative thinking.

Then the learning strategy needs a little change in the learning process by increasing the high-level thinking skills in the classroom. According to Lewy et al [8] also said that good learning is learning that familiarizes problem-based learning, persuade students to always explain and maintain the process and results of their work from criticism launched by their friends, accustom students to solve problems with a variety of strategies (open ended approach) and invite them to evaluate these strategies in terms of effectiveness, efficiency, and carrying out reflective practices (by keeping journal).

Kartwohl in Lewy et al [8] said the indicators used in measuring high-level thinking skills include analysis, evaluation, and creation. Krathwohl in Suryapuspitarini, et al [1], indicators for measuring high-level thinking skills in creating category include: generalizing an idea or perspective, designing problem-solving strategy, organizing elements to construct new structure. Creation is the ability to combine elements to form a new and unique structure, design techniques, and find multiple solutions [9].

Student exercise during learning process will provide knowledge, attitudes, and skills to the students, and allow the teacher to measure students' ability to understand a specific material subject, develop and apply learning material that is considered difficult to be conveyed verbally.

2. Methods

The method applied in this study is design research. The purpose of development research is to generate a valid, practical, and potential creating category HOTS mathematics exercise for high school students. The validity of the exercise based on the results of the walkthrough from the expert, afterward the questions will be tested with students in a one to one process. The practicality of the exercises will be seen from the teacher and students who are easier to use. Potential effects can be seen at the small group stage, and field tests show students' mathematical literacy abilities. The implementation is carried out in two stages: preliminary or preparation, and formative evaluations which include self-evaluation, expert reviews, one-to-one, small group, and field tests [10]. Figure 1 shows the development process carried out in this study.

![Figure 1. The Process of Formative Evaluation Design [11]](image)
Subjects of the study were 33 students of class XII of SMA Negeri 1 Palembang. Techniques for collecting data used documents, walkthroughs, tests and interviews. Documentation’s data is comments and suggestions of student work on HOTS exercises conducted during one-to-one, small groups, and field tests. walkthrough is carried out with expert review, in its validation activity the researcher aims to get comments and suggestions from the expert so that the prototype can be developed by the researcher can be seen as valid. The test data is the results of students’ score and interview data is information about the questions while the Observation data is information on difficulties experienced by students in solving HOTS type questions. Data analysis techniques include document analysis, walkthroughs, tests, interviews and observations.

3. Result and Discussion
The stages that were carried out in the process of developing the HOTS problem occurred in two stages, namely the preliminary and prototype stages. In the preliminary stage, determining the subject and place of research and analyzing the 2013 curriculum that researchers used as a basis for developing HOTS exercises was Geometry material for Class XII High School. The researcher identified HOTS exercises in terms of content, context, literacy process and the level of HOT that used. The level of exercises created in the study is the level of creating (C-6). Researchers design the HOTS question instrument in the form of a grid, cardboard, and assessment rubric. The prototype stage consists of self evaluation, expert review, one to one, and small groups. In the Self Evaluation phase, the researcher must review the initial prototype in order to checking if there are still errors in the questions that have been designed so that the prototype can be used to the next stage of the process. The researcher asked one of the mathematics teachers to give suggestions and input in terms of content, construction and language in the use of the exercises designed by the researcher. Suggestions and input obtained from the teacher will be used as a guide and reference in revising HOTS type math exercises. The results of prototype 1 are as follows:

The giant Alquran Museum, located in Gandus Sub-district of Palembang city, which attracts very popular tourist visitors among Muslims. It was published exactly on January 30, 2012, by Mr. President Susilo Bambang Yudhoyono (SBY). Alquran carved on trambesi wood with a size of 170 cm, 132 cm and 2.5 cm respectively. In the middle there is a 4 cm wide support pole and the distance of the support pole with the end of the Qur'an 5 cm when closed. What is the distance of the Al-Quran sheets that are aligned on the left and right sides of the mother.

Figure 2. Results of HOTS’ Exercises C6 Prototipe 1

The Expert Review and One-to-one stages are carried out simultaneously. The Expert Review consists of 2 experts of mathematics who assess content, constructs and languages that produce:

| Expert Review 1 | The image is replaced with the original image |
|------------------|---------------------------------------------|
|                  | The first letter of the word in the question |
|                  | ‘circle’ should best replace with big letters |

| Expert Review 2 | Pay attention with use letters that state places |

The one-to-one process, prototype 1 exercises will be tested on 3 (three) students with different abilities namely, high, medium and low.
Table 2. Students’ comments one-to-one process

| Student 1 | Student 2 | Student 3 |
|-----------|-----------|-----------|
| Images can be helpful because they provide information position of the Al-Quran sheets. The stimulus in the problem is not necessary. There is a distance between the supporting pole and the edge of the Quran sheet if the Quran position is closed. | the picture can provide information | The picture helps because we can know the angle of the Qur'an sheet. |

The revision of prototype 1 serves as a matter of prototype 2, which is as follows:

The giant Alquran Museum, located in Gandus Sub-district of Palembang city, which attracts tourists is very popular among Muslims. It was published exactly on January 30, 2012, by Mr. President Susilo Bambang Yudhoyono (SBY). Alquran carved on trambesi wood with a size of 170 cm, 132 cm, and 2.5 cm respectively. In the middle there is a supporting pole 4 cm wide and the distance of the supporting pole with the left and right ends of the Qur'an 5 cm when closed position. What is the distance of the Quran sheets parallel to the left and right side of the mother.

Figure 3. HOTS exercises C6 Prototype 2 results

Prototype 2 exercises that have been produced, will be tested into a small group process consisting of 6 students with low, medium, and high ability. Each of the processes carried out by this prototyping, prototype mathematical problems of HOTS type developed by researchers have several revisions and questions developed it will be valid and practical.

The results of observations and interviews conducted by researchers with students in the process of small groups, students can solve problems well developed by researchers, without problems that make students unable to do the problems at all. Based on observations and interviews, the exercises developed by researchers do not need to be revised again because students can understand well the intentions of the questions. Then the results of the questions that were tested in the small group process with the six students with different abilities will be made as a prototype problem 3. The results of Prototype 3 are as follows:

The giant Alquran Museum, located in Gandus Sub-district of Palembang city, which attracts tourists is very popular among Muslims. It was published exactly on January 30, 2012, by Mr. President Susilo Bambang Yudhoyono (SBY). Alquran carved on trambesi wood with a size of 170 cm, 132 cm, and 2.5 cm respectively. In the middle there is a supporting pole 4 cm wide and the distance of the supporting pole with the left and right ends of the Qur'an 5 cm when closed position. What is the distance of the Quran sheets parallel to the left and right side of the mother.

Figure 4. Results of HOTS exercises C6 Prototype 3
The field test process used was an exercise of prototype 3 to be tested on students of class XII IPA of SMA Negeri 1 Palembang. The purpose of the researchers’ implementation of the process is to see how the potential effect of the HOTS exercises on mathematical literacy skills.

3.1. Discussions

The development stage of HOTS type math problems in this study includes preliminary and formative evaluation with Tessmer development. The formative evaluation process includes self-evaluation and prototyping process, while the prototyping process is an expert review with experts, one-to-one with three students with different abilities, a small group with 6 students who are divided into two small groups and in proceed to the field test process with one class. Every time the prototyping process is carried out, the HOTS type mathematical prototype developed by the researcher have several revisions and exercises developed become valid and practical. This prototype 3 question is a research product produced by researchers.

HOTS exercises are developed according to its characteristics in carrying out validation with experts, the expert already has experience about HOTS exercises. Simultaneously the validation was carried out with an expert, the researchers tried out the exercises that had been developed to three students with different abilities namely low, medium and high, the process carried out by this researcher was called one-to-one. In a one-to-one process

In a one-to-one process, the researcher focused on students understanding about the purpose of the exercises, the use of terms in the problem, the picture used in the problem.

Then the next process the researchers conducted a trial into a small scale on the revised basis based on expert review and one-to-one. The results of the revised expert review to answer the research goal is to get valid questions. The validity of the questions was assessed based on content, construct and language. Indicators used by experts to validate HOTS type math exercises include:

| Domain   | Aspects analyzed                                                                 |
|----------|----------------------------------------------------------------------------------|
| Content  | • Compatibility with HOTS Indicators creates (C.6)                               |
|          | • Compatibility with the Problems according to HOTS characteristics              |
|          | • Material is arranged hierarchically                                            |
| Construct| • Learning starts with a problem,                                                |
|          | • Problems given relate to the daily life of students,                          |
|          | • Problems can challenge students for new knowledge,                             |
|          | • Students have responsibility for investigating problems                        |
|          | • Students experience directly their own learning process,                      |
|          | • Using small groups,                                                           |
|          | • Demanding students to demonstrate what they have learned in the form of products or performance, |
|          | • Images are clearly and legibly presented.                                     |
| Language | • Formulation of communicative sentences,                                        |
|          | • Compatibility with Enhanced Spelling (EYD)                                    |
|          | • The sentence is easy to understand and does not give rise to multiple interpretations or misunderstandings, |
|          | • Consistency of letters and images.                                            |
The small group process is used to answer the research objectives, namely the level of practicality of the questions developed by the researcher. When the problem can be understood properly, easy to read and does not bring up some other interpretations, then the exercises that has been developed by the researcher can be said to be practical.

The implementation of field tests in 33 students of class XII of SMA Negeri 1 Palembang was used to see how the potential effects on mathematics literacy. Seeing the potential effects of the questions in this study are the basic basic abilities of mathematics (KDM). The discussion presented by students regarding the ability to create (C6) in working on HOTS type exercises of high school geometry material is as follows:

![Figure 5. Answers by R. Y. P. and by M. I. M](image)

From the results of the field test students, their answers show the ability to analyze information in questions and pictures, make generalizations of ideas or ways of looking at things, the ability to design strategies to solve problems and the ability to organize an element or part into a new structure may never exist. The rest is done by students experiencing a lot of mistakes in interpreting the information in the problem then the way to make quick conclusions does not count systematically anymore.

4. Conclusion and Suggestion

Based on the research results and discussions, we can conclude as follows:

- This research has produced high-level thinking exercises (HOTS) the ability to create (C 6) that is valid and practical. Valid seen from the results of the validation carried out with the expert / expert who became the validator of the questions, they stated both in accordance with the content / construct, and language. In the one to one stage the questions that are tested get comments / suggestions from students. While practically can be seen from the test questions generated, students are able to use a good set of exercises. After the problem has been declared valid and practical, it is then tested in the field test stage to determine the potential effect of the problem on mathematical literacy abilities.
- Potential effects can be seen from the results of students' answers at the field test stage, which shows the ability to analyze the information contained in the exercises and make ideas or points of view in making the design of problem solving by organizing elements into new structures that may never exist before.

We would also like to suggest:

- Educators, the results of this research can be used as an alternative exercise in learning mathematics.
- Researchers can develop HOTS exercises in analyzing categories (C 4), evaluating (C 5) with different material.
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