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The development of HOTs problems on probability and statistics for middle school

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Abstract. The lack of using high-level thinking questions (HOTs) in schools requires Indonesian students to be less successful in solving problems that demand that ability. To improve the quality of education, the government revised the curriculum which in its development refers to one of the aspects that must be raised in the learning process is HOTs. This research aims to produce valid and practical as material for student's training and see the potential effects of these questions on students' mathematical literacy abilities. This study uses the design research method for the type of development study with eighth-grade students of SMP Negeri 1 Palembang as the subject of the research. The results of the study showed that the HOTS problem developed discussed material aspects, constructs, and languages that were declared valid and practical and were feasible to use.

1. Introduction

Based on the 2013 curriculum in the ministry of education and culture in 2017 as stated in the syllabus, one of the aspects of learning that must be given to junior high school/MTs students is opportunity and statistics. However, the majority of students still have difficulty in solving questions related to the material. The low knowledge and skills of students in using mathematical knowledge they have in solving real problems have always been a concern in the world of education. Plus if students cannot solve questions that use a high level of thinking in its completion. The high level of thinking ability of students who are still low is one of the reasons educators and researchers continue to strive for improvement, one of them is by developing questions of high-level thinking.

One reason is that students have not been trained to work on problems that require high-level thinking skills, due to the provision of training in routine questions [1]. In addition, according to [2], based on experience in the field the writer found that the majority of which had been taught in schools were closed problems, which in solving these closed mathematical problems, the procedures used were almost standard. Students are rarely invited to analyze and use mathematics in everyday life. In line with what happened at school, in reality, the questions given tended to test the memory aspect more, which resulted in a lack of trained Higher Order Thinking Skills (HOTS) or high-level thinking skills of students. In fact, if some aspects contained in the curriculum such as Competency Standards and Basic Competencies on mathematics subjects are developed, it can produce HOTS type questions.

Educators use questions with a high level of thinking ability because the use of these questions would have a potential effect on the results of level thinking skills tests [3]. In addition, the Ministry of Education and Culture also targets to continue increasing the percentage of HOTS in the National Examination to improve the quality of education in Indonesia. "This year the issue of HOTS is only 10 percent. The next year will be gradually increased. A maximum of 20 percent;" said Director General

of Primary and Secondary Education Hamid Muhammad in his office on Monday (23/4) [4]. This shows that we need more HOTS type questions.

HOTS is the ability to think critically, logically, reflective, metacognitive, and creative thinking which is a high-level thinking ability. HOTS is a thought process by students at a higher cognitive level. According to [5], HOTS is the ability to think which requires not only the ability to remember but also a higher ability. HOTS is included in critical, logical and creative thinking. This ability active when a person is faced with a problem, uncertainty, question or dilemma. HOTS are the last three aspects of Bloom's taxonomy namely analyzing, evaluating, and creating [6].

HOTS type questions are questions that require high-level thinking skills and also involve reasoning processes so that they sharpen critical, logical and creative thinking skills. This HOTS type problem trains students to be able to think at the level of analysis, evaluation, and creation [7]. HOTS type questions in the context of assessment measure the ability to transfer each other from transferring from one concept to another, processing and applying information, which then determines the relationship between different information, and uses that information to solve problems and critically examine information and ideas [8].

According to [9] in A revision of Bloom's Taxonomy, states that the indicators used to measure high-level thinking skills include the ability to analyze (C4), evaluate (C5) and create (C6). Analyzing (C4) is separating concepts into several parts and how they are connected to each other to gain an overall understanding of the concept. C4 includes distinguishing, organizing and attributes. Evaluating (C5) is making judgments based on criteria and standards. C5 includes checking and criticizing. Creating (C6) is combining elements into a whole new form, or making something original. C6 includes producing, planning and producing.

Indicators of high-level thinking skills in the domain of taxonomy bloom are analysis, evaluation, and creation. (1) analysis (analyzing) is the ability of students to detect how material or part is related to one another. The ones that can be included in the analyzing category are distinguishing; when students can distinguish which parts are interconnected from the material given, organize; when students can determine a material whether it matches the problem given and connects; when students can determine the core of the material given. (2) evaluating is making a decision based on certain criteria, checking or criticizing. Checking here means that students can identify the truth or error of the procedure being applied or even the material related to the material given, while criticizing is when students can detect incompatibility between decisions and procedures for the problem given, giving opinions and so on. (3) creating that is when students can put a component together to form a coherent whole or make something such as arranging an invention based on the hypothesis taken in accordance with the criteria that have been given, and determine a way to design and complete the task given which then produces with a product according to the description given.

Preparation of HOTS questions generally uses a stimulus which is the basis for making the questions presented are contextual and interesting. This stimulus can be sourced from global issues or even the problems surrounding the environment.

2. Research Method

The research method used by researchers is the development of a design research type of development study [10] The purpose of this type of research is to produce a HOTS math type analysis for junior high school students. The subjects of this study were eighth-grade students of junior high school. This research was conducted in the odd semester of the 2018/2019 academic year in Palembang 1 Public Middle School. The instruments of data collection are in the form of Walkthroughs, tests, observations, and interviews.

This research is intended to design HOTS questions for junior high school students and develop these questions so that they become valid and practical questions. This research was conducted in two stages, namely the preliminary stage (preparation) and the formative evaluation stage [11] which included self-evaluation, prototyping (expert reviews and one-to-one, and small group), and field tests. These stages can be seen in the following of figure 1.
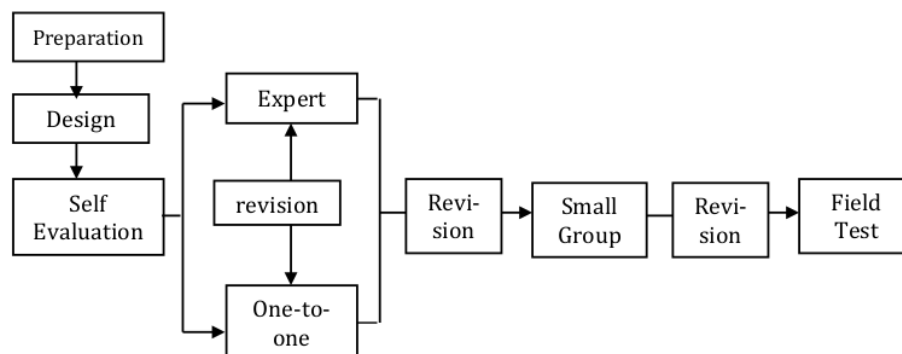
Figure 1. Design formative evaluation

The Preliminary Evaluation stage is where the researcher analyzes the characteristics of the HOTS problem, analyzes the basic competencies of the questions developed based on the curriculum, determines the subject and schedule of the study, and the work procedures implemented. Then the design stage where at this stage, the researcher designed a device that consisted of designing a grid and question cards that were in accordance with the characteristics of the HOTS problem. The design process is based on 3 characteristics, namely content/construct, language and language, which will then be validated by the experts.

The Formative Evaluation stage consists of Self Evaluation, where the researcher self-assesses HOTS mathematical questions that have been designed. If the questions have been considered good enough by the researcher, then the result of this designation is called the first prototype (Prototype 1). Expert Review is a question that has been designed to be validated by experts, by being examined, assessed and evaluated. Validation includes validation of content, constructs, and language. One-to-one is that researchers conduct tests on individual students. Students are asked to observe, work and give comments on the questions that have been designed. Results from one-to-one are used to revise prototype 1 products. The revised results are called prototypes 2. After this stage, the questions in prototype 1 can be categorized as valid.

Small groups are where there are 6 students apart from the chosen research subject. Criteria for the ability of students selected consisted of 2 low-ability students, 2 moderate-capable students, and 2 high-ability students. Evaluate this small group to see the practicality of the questions that have been developed. Results from this small group became prototype 3.

3. Results and Discussion

3.1. Analysis Stage

The activities carried out at the analysis stage of the students are observing and visiting the school for the purpose of conducting the research, namely SMP 1 Palembang. Then the researcher discussed with the subject teacher (class teacher) who would be the subject of research, namely Nurjanah, M.Pd. This discussion aims to explain the research procedure, determine the subject of research at the stages of the research methodology

At the curriculum analysis stage, the subject matter is identified based on the curriculum used in the school where the research is conducted. The discussion was also conducted to adjust the curriculum used where Palembang 1 Public Middle School was implementing the 2013 curriculum.

At the analysis of the problem, HOTS researchers analyzed the HOTS type, by finding out the characteristics of the HOTS problem itself which aims to determine the shape of HOTS type questions.

3.2. Design

At the design stage, researchers began designing and compiling HOTS math problems. The questions that are designed are intended for eighth-grade students of junior high school. Below are the results obtained from the design in the form of an instrument consisting of:

* The grid of HOTS math questions.
* Math card type HOTS for SMP.
* Rubric assessment of HOTS math problems for junior high school.

This design phase produces 10 items consisting of 7 questions of uncertainty and data and 2 questions of opportunity.

3.3. Evaluation Stage

3.3.1. Self Evaluation

At this stage HOTS math problems have been designed, examined by researchers. This aims to find and correct mistakes or deficiencies during the process of designing the problem. During this process, the researcher is also assisted by a supervisor in examining the questions that have been designed by the researcher during the consultation prior to the implementation of the research.

3.3.2. Expert reviews

The validity of HOTS math questions can be seen in terms of content, constructs, and language. Before being given to the expert, these questions have been discussed previously with the supervisor. The experts who reviewed this device were Dr. Destiniar, M.Pd, Dr. Yusuf Hartono, Dr. Bambang Suprihatin, Nurjannah, M.Pd. Here is a recapitulation of expert suggestions and comments.

Table 1. Recapitulation of Expert Suggestions and Comments

Question	Comments and Suggestions
1	Dr. Destiniar, M.Pd.

Problem 1: For each unit, the non-February questions are described "question 1, question 2, and so on". Just make one question with the information needed. If there is more than one question from each unit of the problem then just add information such as a, b, c ...

Dr. Yusuf Hartono

Problem 1: use the verb that is in the taxonomy of bloom for the HOTS category. For example on the C5 verb for HOTS is "compare". So, the word should be used on a problem predicted to have level 5.

Problem 1: When viewed from the picture (given graph), the question makes students not think high, because it has already been seen which country is the first

Question	Comments and Suggestions
	winner with the high medal gain seen clearly on the chart. It is better to look for data that makes students not immediately able to guess which country is the champion. If you are only told to make a graph based on the data presented in the table, then it does not include HOTS. It would be different if there were several display images that represented the data in the table presented, and students were told to choose which suitable image according to the table. This will make students more analyze and think.
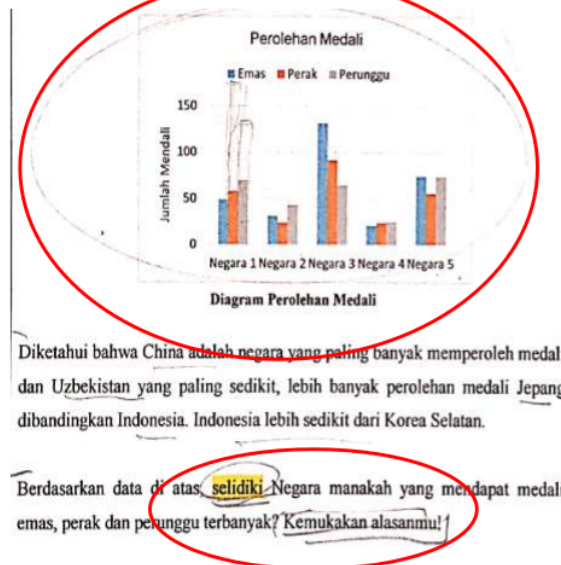
Diketahui bahwa China adalah negara yang paling banyak memperoleh medali dan Uzbekistan yang paling sedikit, lebih banyak perolehan medali Jepang dibandingkan Indonesia. Indonesia lebih sedikit dari Korea Selatan.

Berdasarkan data di atas, selidiki Negara manakah yang mendapat medali emas, perak dan perunggu terbanyak? Kemukakan alasanmu!
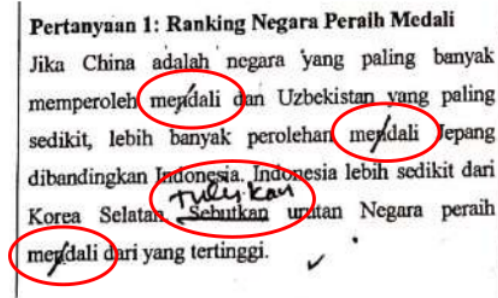
Dr. Bambang Suprihatin

Note writing capital letters. In the words "country", n is written lowercase. In writing "games", the letter g is written in capital letters and italicized because "games" are foreign languages. Then for the sentence structure in the description of objects, the question does not write down what the object is less so that the sentence becomes ambiguous. In the phrase "at least" add a statement. Because the purpose of the fewer questions is the acquisition of a number of medals, then the sentence made into "the acquisition of an Indonesian medal is little more than

| Question	Comments and Suggestions
	South Korea. Besides that, writing "Korean" must be consistent. If what is meant is "South Korea", it must always be written "South Korea".
Nurjannah, M.Pd.	

Pertanyaan 1: Ranking Negara Peraih Medali

Jika China adalah negara yang paling banyak memperoleh mendali dan Uzbekistan yang paling sedikit, lebih banyak perolehan mendali Jepang dibandingkan Indonesia. Indonesia lebih sedikit dari Korea Selatan. Sebutkan urutan Negara peraih mendali dari yang tertinggi.

	The word "mendali" should be replaced with the word "medal". Pay attention to the other sentence structures to match EYD.

The following display of the questions before a revision can be seen in Figure 2.

Gambar 1 menunjukkan perolehan medali yang diraih lima Negara teratas pada Asian games ke-18 tahun 2018.
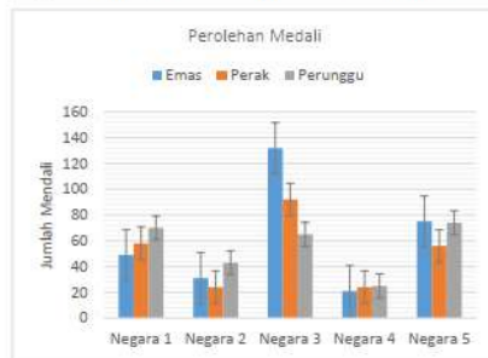
Gambar 1 Diagram Perolehan Medali

Figure 2. Question 1 prior to revision

a. Jika China adalah negara yang paling banyak memperoleh medali dan Uzbekistan yang paling sedikit, lebih banyak perolehan medali Jepang dibandingkan Indonesia. Indonesia lebih sedikit dari Korea Selatan. Tuliskan urutan Negara peraih medali dari yang tertinggi.

Figure 3. Question 1a prior to revision.

Gambar di bawah ini menunjukkan perolehan medali yang diraih empat negara pada Asian Para Games tahun 2018.
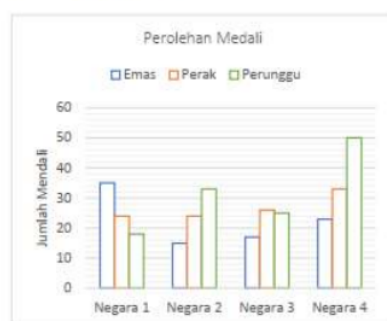

Diagram Perolehan Medali

Berdasarkan data di atas, selidiki Negara manakah yang menduduki peringkat tertinggi? Kemukakan alasanmu!

Figure 4. Question 1 after revision.

3.3.3. One-to-One
Stage one to one is done in parallel with the expert review stage. At this stage, the researcher tests the questions to 3 students with each having high (FF), medium (RS) and low (RB) abilities. Then students are asked to read the questions in prototype 1, which number 13 questions and solve them. This aims to observe the response and difficulties of students when working faithfully on the items developed. The researcher here only acts as a facilitator who oversees and assists students when they have difficulty answering questions.

3.3.4. Small Group
In the small group stage, the researchers tested the revised prototype 1 called prototype 2 for 6 students of class VIII Palembang State Junior High 1 consisting of 2 high-ability students (ND and NA), 2 students with the moderate ability (FF and VF) and 2 low-energy students (NY and JR). Then students are asked to work on these questions, where students consist of high, medium and low ability students. After working on the questions, students were interviewed to find out the obstacles experienced when working on the problem.

3.4. Field Test
At the time of the field test, the model teacher starts by giving direction related to the execution of the questions. Then the teacher distributes the activity sheet in the form of a prototype 3. Students are asked

to read and understand the problem first, the teacher instructs students to work on the questions on the activity sheet. The following is an overview of students when carrying out the test.

Figure 5. Class VIII.8 Student Test Implementation

When the class VIII 8 test is supervised by the teacher and the test process is enforced in an orderly manner. Students are given 90 minutes. The following is shown the student's answer. In question number 1, students are asked to investigate the countries that have the highest rank in the 2018 Asian Para Games, based on the achievements of medals in each country which are presented in the form of diagrams. From the results of the analysis of student answers, it can be seen that this problem raises representation capabilities (a) and communication skills (b) students, because students can rank the highest country in the Asian Para Games by using medals (gold, silver, and bronze) from each country presented in the question. There are several differences in how students find solutions to these problems.

Figure 6. Student's answer problem 1 (type 1).

Figure 7. Student's answer problem 1 (Type 2).

For example, the first student (type 1) analyzes the data on the graph. He knew that the ranking of a country was determined by how many gold medals were obtained by the country. He interpreted that the more gold medals achieved by a country, the higher the rank of the country. Students can answer questions correctly, that is, the highest-ranking country is country 1. From the student's answers, we can see that students show they can use various representations to solve a problem correctly.

Then the second student (type b), find a solution by calculating the points of each medal obtained. He interpreted that the gold medal earned 3 points, the silver medal earned 2 points and the bronze medal earned 1 point. Then the student calculates the total number of points based on the state medal gain based on the data presented. Students can answer questions correctly, namely country 1 which gets the highest rating. From the student's answers, we can see that students show they can recognize a problem, then interpret the object to get a solution that is summarized from the problem-solving processes. From the analysis of student answers, it can be seen that 16 of the 26 students showed representational abilities and communication skills.

Based on the analysis of students' answers, overall some students still have difficulty in solving HOTS type math problems. This is because students are not accustomed to working on high-level thinking questions.

4. Conclusion
This study resulted in a HOTS math tool for junior high school uncertainty and data material and a 10-item chance that was valid and practical. The development of questions uses the characteristics of the HOTS problem which consists of 3 C4 items, 5 C5 items, and 2 C6 items. The validity of sola is seen in terms of content, whether the matter of question is appropriate; contract, whether the questions are in accordance with the characteristics of high-level thinking questions (HOTS) and the ability of junior high school students; and language, whether the questions have used language that is good and true and according to EYD and can be understood by students. This is done at the stage of expert review and one to one. Furthermore, the practicality of the questions can be seen from the results of the small group, where HOTS type mathematical questions use contexts that are known to students, are easy to understand, and can be used in learning.

5. Acknowledgments

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