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## The Development of HOTS-Based Mathematics Teaching Materials in Elementary School

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Abstract. Teaching material is one component that occupies an important role in the learning process. Teaching material with HOTS component will be able to clearly distinguish ideas or ideas, argue well, be able to solve problems, be able to construct explanations, be able to hypothesize, and understand complex matters more clearly. The research aims to produce valid, practical, and effective HOTS-based mathematics teaching materials in elementary schools. The research type is research and development (R&D). The subjects of this study were students and teachers of SDN 4 Ngawen Blora. Data collection techniques used were interviews, questionnaires, and tests. The research result presented is based on the results of limited trials. To this research, it was found that the average mathematics learning achievement increased from 57.50 to 86,50. The prototype of HOTS-based mathematics teaching materials that was developed has shown good results with a percentage of assessment by the teacher of 95.45%. Students show an interest in HOTS-based mathematics teaching materials. Students feel challenged by the activities and learning activities presented. However, a few things need to be fixed, that is unclear pictures of the presentation aspect to students. Additionally, the teacher also provides suggestions and input on improvements to the HOTS-based mathematics teaching material prototype. The suggestion given includes replacing unclear images and providing explanations that match with the image, enlarging the image size that contained in the prototype, and correcting typographical errors. Moreover, the revised prototype results will be used in further trials.

#### 1. Introduction

Mathematics is a universal science that underlies the development of modern technology, has an important role in various disciplines, and advances human thinking. The rapid development in the field of information and communication technology is based on the development of mathematics in the fields of number theory, algebra, analysis, probability theory, and discrete mathematics. To master and create future technology requires a strong mastery of mathematics from an early age.

Education is the most important and influential aspect to create a nation that's ready to face problems in the globalization era. However, education quality in Indonesia is still in the low category. It is supported by the results of the PISA study [1]. The results showed that Indonesian students' ability in mathematics achieved an average score of 379 with an OECD average score of 487. It makes

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI. Published under licence by IOP Publishing Ltd 1 Indonesia ranked 72 out of 78 PISA participating countries. The low math ability of students is influenced by several factors, one of which is the condition of the teaching material.

Problems related to mathematics are the main problems that occur in the world of education. In the learning process, teaching materials is the most important thing in process of delivering material to students. The material contained in the learning book is not in-depth, causing students to only understand learning material at the basics of the material. Therefore, teachers need to find other learning resources in form of teaching materials that can add insight to learning materials.

Teaching material is one component that occupies an important role in the learning process. The use of teaching materials as a learning resource aims to facilitate the preparation and delivery of learning materials used by teachers to achieve learning objectives. Teaching materials are all materials (both information, tools, and text) that are arranged systematically, which depicts a complete figure of competencies that will be mastered by students and used in the learning process with the aim of planning and studying the implementation of learning [2].

Along with the times, teachers are required to be more creative in developing teaching materials. This is in accordance with Permendiknas Number 41 of 2007 concerning Process Standards, which regulates the planning of the learning process which requires teachers to develop a Learning Implementation Plan (RPP). One of the components of the lesson plan is a learning resource so that teachers are expected to be able to develop teaching materials as a learning resource. The 2013 curriculum should have directed HOTS learning. However, in reality, the learning carried out in schools currently revolves around learning that contains Low Order Thinking Skills (LOTS) which is oriented towards memorization and simple understanding. Individuals are faced with increasingly complex problems so that learning must be change and lead to HOTS-loaded learning.

One of the transformation elements in the 2013 curriculum at the elementary school level is the strengthening of the learning process. Through strengthening the learning process is expected to improve the quality of learning more effectively, efficiently, fun, and meaningful, to improve the quality of achievement of learning outcomes and put students forward critical thinking (not just convey factually). Teachers must be able to develop and convert from Lower Order Thinking Skills (LOTS) learning to Higher Order Thinking Skills (HOTS).

Higher Order Thinking Skills is a thinking process of students at a higher cognitive level that is developed from various cognitive concepts and methods and learning taxonomies such as problemsolving methods, bloom taxonomy, and learning, teaching, and assessment taxonomies [3]. Higherorder thinking skills include problem-solving skills, creative thinking skills, critical thinking, argumentation skills, and decision-making abilities.

With higher-order thinking students will be able to clearly distinguish ideas or ideas, argue well, be able to solve problems, be able to construct explanations, be able to hypothesize, and understand complex matters more clearly [4]. Higher-order thinking skills will occur when a person associates new information with the information already stored in his memory and associates it and/or rearranges and develops the information to achieve a goal or find a solution of a difficult situation to solve [5]. The main objective of higher-order thinking skills is how to improve the thinking skills of students at a higher level, especially related to the ability to think critically in receiving different types of information, creative thinking in solvTng a problem using knowledge possessed, and making decisions in complex situations [3].

The purpose of the research is to produce HOTS-based math teaching materials in primary schools that are valid, practical, and effective. Based on the description above, the researcher is interested in researching the development of mathematics teaching materials based on high order thinking skills for grade IV elementary school students.

The development of math teaching materials is currently necessary to be done immediately. Learning in the 2013 Curriculum leads to the HOTS principle, therefore it is the most pressing reason for developing mathematics teaching materials. The results of the development of mathematics teaching materials are to provide more varied learning resources so that they can foster student interest

in learning, help students improve critical thinking skills, provide opportunities for students to be able to apply the knowledge that they get at school directly in their daily life.

#### 2. Method

This research uses the Research and development (R&D) method, namely research that produces products and tests the effectiveness of the products produced [6]. There are 10 steps in research and development [7]. Development method adapted into four stages, namely the exploration, model development, model testing, and model dissemination and implementation stages [8]. Subjects of this study were fourth-grade students and teachers of SDN 4 Ngawen, Blora Regency. The number of students used as a sample is 8 children, and one teacher. The sampling technique in research is used random sampling technique.

Data collection instruments used in this research were questionnaire sheets, interviews, and tests. The questionnaire sheet was used to determine the teacher's response to the use of the teaching material prototype. Interview sheets are used to obtain suggestions and input from teachers regarding the products being developed. While the test is used to measure student learning outcomes before and after using teaching materials. Test is a series of questions or exercises and other tools used to measure skills, intellectual knowledge, or other abilities possessed by individuals or groups [9].

The results of the research presented are based on the results of limited trials. The data analysis used in this research is qualitative and quantitative. Data analysis in the preliminary stage, namely the Miles and Huberman model through four steps, namely data collection, data reduction, data presentation, concluding [10].

Checking the validity of the data is one way to account for the accuracy of the data that has been obtained [10]. The data validity test was conducted using triangulation techniques. Triangulation of data collection techniques was carried out to test the credibility of the data by checking the same data source with different techniques. After the data needed in this study were collected, the data was organized and systematized before being used as material for analysis. The triangulation techniques used in this study were interviews, questionnaires, and tests. The data analysis technique used was the interactive analysis through data collection, data reduction, data presentation, and data verification [10]. The results of the data analysis were presented using qualitative descriptive with narrative text to determine the response of teachers and students to the use of HOTS-based mathematics teaching materials in elementary schools.

#### 3. Result and Discussion

The research results presented are the results of limited trials in this R&D research. Based on the results of tests given to grade 4 elementary school students, the following data were obtained:

Tabel 1. Student mathematics learning outcomes				
Variable	Pretest	Postest		
Average	57,50	86,50		
Ν	8	8		

Based on table 1, it can be explained that before using HOTS-based mathematics teaching materials the average value of students' mathematical abilities obtained was 57.50. After using HOTS-based mathematics teaching materials the value obtained was 84.75.

There is an increase in average student learning outcomes. Higher Order Thinking Skills is a thinking process of students at a higher cognitive level that is developed from various cognitive concepts and methods and learning taxonomies such as problem-solving methods, bloom taxonomy, and learning, teaching, and assessment taxonomies [3]. Higher-order thinking skills include problem-solving skills, creative thinking skills, critical thinking, argumentation skills, and decision-making abilities.

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Teaching materials have several roles, including: 1) reflecting a sharp and innovative point of view regarding teaching and demonstrating its application in the teaching materials presented; 2) presents a rich source of subject matter, easy to read and varies according to the interests and needs of students; 3) provide an organized and gradual resource; 4) presents the methods and means of teaching to motivate students; 5) to be a support for practical exercises and tasks; 6) presenting appropriate and appropriate evaluation and remedial materials/tools [11]. After the implementation of the student learning outcomes test was completed, the fourth-grade teacher as the pilot was asked to provide an assessment of the HOTS-based mathematics teaching material prototype. The assessment is in the form of a questionnaire which consists of four aspects, namely 1) Description of the contents of the teaching material, 2) Presentation of displays, pictures, tables, and charts, 3) Readability, and 4) Learning. The results of the teacher questionnaire sheet can be seen in Table 2 below.

Tabel 2. Questionnaire Assessment Results			
No	Assesment Component	Score	
1.	Description of the content of teaching materials	18	
2.	Presentation of views, pictures, tables and charts	27	
3.	Legibility	20	
4.	Learning	19	
Total Score		84	
Percentage		95,45%	

From the data obtained, it shows that the HOTS-based mathematical teaching material prototype developed has a sufficient category, so it is necessary to carry out an evaluation and improvement of the worksheets developed to achieve better results.

The results of the initial field trials carried out can be concluded as follows:

- a) Content Aspects of Teaching Materials
  - The results of the limited trial were seen from the content aspect, based on the student and teacher questionnaire showing that students had no problems in understanding the content of the presentation of the HOTS-based mathematical teaching materials prototype. The questions presented in the worksheet can optimize students' independent learning.
- b) Presentation aspects of views, pictures, tables, and charts In terms of display presentation, pictures, tables, and charts on the teaching material prototype, everything is good. However, there are still images that are unclear and there is no explanation for these images.
- c) Readability Aspects

From the legibility aspect, it shows that the use of writing and the language used in the HOTSbased mathematical teaching material prototype is good. However, there are some hyphens and spaces where there are still errors.

d) Learning Aspects

In terms of learning, the HOTS-based mathematical teaching material prototype is good enough. The teaching materials developed have attracted students' attention and can encourage students to be more active.

To obtain teaching materials that are in accordance with the demands of competency that must be mastered by students, analysis of the curriculum, analysis of learning resources, and determination of the type and title of teaching materials [11]. Besides, several factors must be considered in developing teaching materials. These factors include accuracy of content, the accuracy of coverage, digestibility of language use, illustrations, compilation/packaging, and completeness of teaching material components [12].

Based on the limited trials conducted, suggestions and input were obtained from the teacher. Improvements to the HOTS-based mathematical teaching materials prototype from the results of the limited trial are summarized in Table 3. Furthermore, the revised results of the HOTS-based mathematics teaching materials prototype were used in subsequent trials.

Table 3. Limited Trial Suggestions and Revisions				
No	Suggestions and Revisions	Improvement		
1.	There is an unclear picture and no explanation for the picture	Replace an unclear image with a clearer one and provide an explanation that matches with the image		
2.	The image size contained in the teaching material prototype is not large enough	Enlarge the image size contained in the teaching material prototype		
3.	Several writing systems are not quite right.	Fix writing errors		

Interviews conducted on students at the limited test stage aim to find out the readability of hotsbased math learning materials that are being developed.

The interview was conducted on five randomly selected students after the math learning activity was completed. The data from the limited trial phase interview is as follows:

- a) HOTS-based math teaching materials are interesting books because of their many drawings and easy to understand students. However, some images are less clear to students.
- b) In terms of material, students consider the material submitted to be interesting. With interesting activities in teaching materials, students feel challenged to conduct existing experiments.
- c) In terms of design, students feel interested in the design in the teaching book. The combination of colors and images in teaching materials is assessed according to the needs of the child.

Based on the results of the interview, it shows that students are interested in HOTS-based mathematics teaching materials. However, a few things need to be fixed, that is unclear pictures of the presentation aspect to students.

This because the teaching materials are closely related to the curriculum, syllabus, core competencies, and basic competencies. The determination of books as teaching materials must meet the eligibility requirements for use in the learning process, it is necessary to assess the feasibility of the content, language, presentation, and graphic of textbooks [13].

#### 4. Conclusion

This study obtained an increase in average math learning achievement from 57.50 to 86,50. The prototype of hots-based math teaching materials developed has shown good results with a teacher assessment percentage of 95.45%. Students show an interest in HOTS-based math teaching materials because they feel challenged by the learning activities and activities presented, a few things need to be fixed, and that is unclear pictures of the presentation aspect to students. Additionally, teachers also provide suggestions and input improvements to the prototype of HOTS-based math teaching materials such as replacing obscure images and providing explanations that match the image, increasing the size of the images contained in the prototype, and correcting writing errors. Furthermore, the prototype revision results will be used in the next trial.

The results of this study can be used as a reference in development of further research, especially with regard to HOTS-based mathematics teaching materials in elementary schools. HOTS can be used as an alternative way that teachers can apply in the learning process mathematics so that students can hone their skills. In addition, this research can be used as input and reference for teachers to improve the quality of learning.

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