

Development of Mathematics Teaching Materials to Improve Higher Order Thinking Skills in Grade 3rd Students in Elementary School

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Abstract

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Mathematics learning in elementary schools is not fully oriented to higher order thinking skills (HOTS). In fact, HOTS play an important role in solving mathematical problems so that they require the support of effective teaching materials. This study aims to produce teaching materials that can improve mathematics HOTS in 3rd grade elementary school students. This research is a development research using the Borg & Gall model. The stages of this research consist of information gathering, development planning, product draft development, and initial product testing. Research data obtained through questionnaires and tests. The data were then analyzed using an interactive model consisting of data condensation, data presentation, and drawing conclusions. The results showed that the product assessment results from material experts were 88.09, media experts were 92.00, linguists were 92.30, and practitioners were 92.24. Considering the results of the validation assessment from several experts, it can be concluded that the mathematics teaching materials developed have been feasible to improve HOTS in grade 3 elementary school students. The development of 3D-based mathematics teaching materials on two-dimensional figure provides assistance for students in solving problems more realistically and easily. Book products are not only in the form of pictures but can be seen, folded or rotated so that they can develop students' thinking in analyzing, evaluating and creating which are adapted to the context of solving mathematical problems in elementary schools.

Keywords: high-level thinking skills, math teaching materials, elementary school

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INTRODUCTION

Higher order thinking skills (HOTS) are related to students' skills in presenting critical arguments in analyzing a problem. The use of HOTS is useful in solving problems that are more real and relevant to everyday life (Baharin et al., 2018; Fitriyani et al., 2020; Siagan et al., 2019; Sumarni & Kadarwati, 2020). The important role of HOTS in mathematics learning can be seen in efforts to solve math problems through math problems given to students (Hadi et al., 2018; Lestari et al., 2021). HOTS involves operational mental operations such as classification, induction, deduction, and reasoning which are often faced with a lot of uncertainty so that it demands various applications through an evaluation process (Merma-Molina et al., 2022; Ripoll et al., 2021). Thus, HOTS needs to be owned by students in learning mathematics.



The importance of HOTS in learning mathematics is not in accordance with the real conditions in the field. The initial measurement through a pretest conducted on 3rd grade students at an elementary school in Surakarta City in the matter of two-dimensional figure obtained that the HOTS was not good. The average analytical ability is 64.35, the evaluation ability is 61.25, and the creative ability is 57.05. Paying attention to the scores on each aspect of the HOTS indicates that students' HOTS gains in solving math problems on flat-shaped materials are still low. Previous research reported that the low HOTS of students in learning mathematics also occurred in several other schools (Eliyasni et al., 2019; Prananda et al., 2020; Tanudjaya & Doorman, 2020). Innovative mathematics learning is needed to support students' HOTS stimulation (Ibrahim et al., 2019; Tambunan, 2019).

In order to improve HOTS, learning mathematics requires interesting and effective teaching materials. Teaching materials are a set of materials and resources that help teachers and students in learning, both written and unwritten (Soraya et al., 2021; Zulyadaini, 2020). Mathematics teaching materials based on numeracy literacy content need to be presented in the presentation of teaching materials that encourage students to learn mathematics which has an impact on student learning outcomes (Hillmayr et al., 2020; Sabil et al., 2021; Putri & Syahputra, 2019). Teaching materials act as one of the learning media that should be designed by the subject teacher in question (Asrial, 2019; Konig et al., 2020). Therefore, teachers must be creative in creating teaching materials that build students' motivation as well as their thinking abilities (Fitriyani et al., 2020; Dewi et al., 2021).

The use of effective teaching materials is expected to stimulate students' HOTS in learning mathematics. Mathematics teaching materials are ideally attractive so that the expected learning outcomes meet the needs of students so that they can meet the standards of student learning outcomes (Kier & Johnson, 2022; Rodríguez et al., 2021). Teaching materials that meet the needs and conditions of students will create interactions with students with a learning climate that is conducive to cognitive, affective, and psychomotor conditions (Assuncao Flores & Gago, 2020; Garzon Artacho et al., 2020). Mathematics teaching materials, especially the material about geometry, play a big role in numeracy literacy (Mahanal, 2019; Marchisio et al., 2022). Therefore, it is necessary to develop mathematics teaching materials to improve students' HOTS (Hasibuan et al., 2019; Ichsan et al., 2019).

This study aims to develop mathematics teaching materials to stimulate higher order thinking. Specifically, the research objectives are to describe 3D-based mathematics teaching materials, find the validity of teaching materials by experts, and initial trials of 3D-based mathematics teaching materials. The urgency of this research is based on the current conditions in elementary schools that have not been supported by 3D-based mathematics teaching materials in flat-shaped materials. The novelty of this research can be seen in the form of teaching materials developed which are based on 3D so that it is different from previous research which is still based on 2D (Perdana & Rahman, 2021; Lestari et al., 2021; Theresia, 2020). 3D Teaching Materials HOTS-Based Two-dimensional figure in Elementary Schools are designed not only to see two-dimensional figure which are usually found in textbooks in the form of pictures, but students can see, fold, and rotate two-

dimensional figure with orientation to the ability to analyze and solve problems. These teaching materials lead to an increase in critical thinking, analytical, and creative skills (Wahyudi et al., 2021). Mathematics teaching materials were developed for 3rd grade elementary school students, especially in geometry learning materials about recognizing two-dimensional figure.

METHODS

This research is a development research with the model used is the Borg and Gall development model. The stages of this research consist of research and information collecting, planning, developing preliminary form of product; and preliminary field testing (Borg & Gall, 1983). At the research and information collecting stage, theoretical studies and research results are carried out that are relevant to teaching materials for flat-shaped mathematics in elementary schools and identify the specifications of teaching materials needed by students and teachers in elementary schools. At the planning stage, the design of 3D-based mathematics teaching materials was carried out to increase the HOTS of elementary school students. The stage of developing the preliminary form of product was carried out by developing 3D teaching materials on flat-shaped materials and product validation was carried out by material experts, media experts, and linguists. The product was then tested on users, namely a class of 3rd grade elementary school students.

The research subjects consisted of 2 material experts, 2 media experts, and 2 linguists, 10 teachers and 15 3rd grade elementary school students. The research site is at SDN Cemara Dua Kota Surakarta. Research and development time from August 2020 to October 2021. The research data was obtained using a questionnaire and test technique. The questionnaire used is an expert and practitioner validation assessment questionnaire on the developed teaching materials. The test instrument used was a mathematical test sheet on flat-shaped material by following the indicators of analysis (C4), evaluation (C5), and creating (C6). The validity of the questionnaire was obtained through content validity and reliability using Cronbach's Alpha of 0.78. Test validity was also obtained using content validity and reliability using Cronbach's Alpha was obtained at 0.86. The data obtained were then analyzed using an interactive model, consisting of data condensation, data presentation, conclusions (Miles et al., 2014).

RESULTS & DISCUSSION

RESULTS

The development of mathematics teaching materials for two-dimensional figure was developed based on the results of the analysis of the needs of teachers and students for mathematics teaching materials to increase HOTS. The teaching materials are developed on a 3-dimensional-based flat wake-up material. The developed 3D-based mathematics teaching materials are presented in Figure 1.



Figure 1. Cover View and Content List

The development of mathematics teaching materials used by teachers and students about two-dimensional figure in the form of 3-dimensional textbooks containing the concept of a quadrangle (square, rectangle, rhombus, kite, parallelogram, trapezoid, arbitrary quadrilateral), the concept of a triangle (triangle) equilateral triangles, isosceles triangles, arbitrary triangles, right triangles, obtuse triangles, and acute triangles), and the concept of a circle. Teaching materials are equipped with student activity sheets, for example folding to find folding symmetry,

counting, and rotating two-dimensional figure to find rotational symmetry.

3D mathematics teaching materials are assessed by experts and practitioners. The expert's assessment is viewed from the material aspect, media aspect, and language aspect. In addition, the practitioners involved were 10 elementary school teachers in Surakarta City. Assessment of teaching materials by experts and practitioners is presented in table 1.

Table 1. Assessment of Teaching Materials by Experts and Practitioners

Type of Validation	Score	Revised aspects
Material Aspect	88,09	Minor revision to add material on types of triangles
Media Aspect	92,00	No revisions
Language Aspect	92,30	Minor revisions to the use of familiar words for 3 rd Grade
Practitioners Validation	92,24	No revisions

As can be seen in table 1, it shows that the results of the material validation test are the need for a slight revision to the addition of the types of triangles. As for what is added is a right triangle, an obtuse triangle, and an acute triangle. The results of media validation show that 92.00 does not require revision and is declared valid. The expert assessment on the language aspect requires revision of the use of words that are simpler and more familiar to 3rd grade elementary school students. The results of practitioner validation showed 92.24 with no need for revision. Thus, in general, expert assessment shows that the teaching materials developed are valid and suitable for use by 3rd grade elementary school students in learning mathematics about geometric shapes.

The product of teaching materials after being assessed as valid by experts and practitioners was tested on 15 3rd grade elementary school students. Students were assessed as HOTS in flat-shaped mathematics at the beginning of learning (pretest) and assessed at the end of learning (posttest). The description of students' HOTS ability data at the beginning and end of learning is presented in table 2.

Table 2. Data Description of Student's HOTS in Mathematics Learning

Group Statistics							
	Group	N	Mean	in	ax		Std. Deviation
Higher-order Thinking Skills	Pretest	15	70.93	5	0	5	4.621
	Posttest	15	88.20	7	4	7	4.887

Table 2 shows the students' HOTS gains at the beginning and end of the flat wake learning. Based on table 2, it can be seen that the average HOTS of students at the end of the lesson is better than before using the developed teaching materials, namely 3D mathematics teaching materials on two-dimensional figure.

DISCUSSION

Development research was conducted at SD Negeri Cemara Dua Surakarta with the results obtained in the form of prototypes of 3D mathematics teaching materials for two-dimensional figure, validation of teaching materials by experts and practitioners, as well as initial trials of teaching materials for 3rd grade elementary school students. 3D-based mathematics teaching materials were developed with quadrangle concepts (square, rectangle, rhombus, kite, parallelogram, trapezoid, arbitrary quadrilateral), triangle concept (equilateral triangle, isosceles triangle, arbitrary triangle, triangle right triangles, obtuse triangles, and acute triangles), and the concept of a circle. The material was developed more fully in accordance with the recommendations of material experts. Improvements were also made to the language aspect, namely by choosing words that were simpler and more familiar to 3rd grade elementary school students. Thus, the teaching materials will be user friendly and make it easier for students to understand the material, analyze and solve problems with two-dimensional figure.

The use of teaching materials that have been declared appropriate by educational experts and practitioners is carried out in grade 3 SD Negeri Cemara Dua Surakarta City. The results of the initial trial of teaching materials showed that after using mathematics teaching materials the results of developing students' higher order thinking skills increased, this was evidenced by the difference in students' average HOTS between before and after using teaching materials. Not only the difference in the average score, the lowest score and the highest score before and after the use of teaching materials also looked real. The highest score on the initial test was only 80 and after using teaching materials the highest score was 94. Thus, the use of 3D mathematics teaching materials was able to have a positive impact on increasing students' HOTS.

The use of 3D mathematics teaching materials in two-dimensional figure helps students' abstraction in the cognitive domain better. Students' understanding of the concepts of rectangles, triangles, and circles is better after using teaching materials through folding and twisting activities. This deep understanding of concepts helps at the evaluation stage so that mathematical problem solving will be better (Alsaleh, 2020; Jaenudin et al., 2020). In addition, the content of the worksheets on the teaching materials developed is also a form of observation activity that does not only see but observes two-dimensional figure through folding and twisting activities. Thus, it is very helpful in exploring the concepts of folding symmetry and rotational symmetry.

This is in accordance with relevant research that has been carried out by previous researchers who have developed mathematics teaching materials for elementary school students. Hidayah & Rofi'ah (2021) research reports that the development that produces a mathematics teaching material based on Higher Order Thinking Skills (HOTS) shows that it is valid, interesting, and effectively used in the mathematics learning process in grade VI with an orientation to analysis, evaluation, and creation. Other research shows that the development of interesting mathematics teaching materials encourages students to construct a good and deep understanding of concepts so as to stimulate critical thinking skills in solving mathematical problems (Munawaroh et al., 2021; Suhartono & Kirana, 2020; Utami

& Dafit, 2021). Although there are differences in the form of teaching materials, content of teaching materials, and users of teaching materials between this study and previous studies, there are benefits that provide facilities for students to improve their thinking skills, especially HOTS in learning mathematics in grade 3 elementary school students.

CONCLUSION

3D-based mathematics teaching materials on two-dimensional figure were developed with an orientation towards increasing the HOTS of 3rd grade elementary school students. The validity of the developed mathematics teaching materials was obtained through product assessments by material experts, media experts, linguists, and assessments by practitioners.

Based on the results of expert and practitioner assessments, it was concluded that the mathematics teaching materials developed were suitable for use by 3rd grade elementary school students in an effort to improve higher order thinking skills. The development of 3D-based mathematics teaching materials on flat-shaped materials provides assistance for students in solving more real problems so that they can develop students' thinking in analyzing, evaluating and creating as an indicator of students' HOTS achievement.

CONFLICT OF INTEREST

Concerning the research, authorship, and publication of this paper, the author(s) reported no potential conflicts of interest.

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