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Developing Problem High Order Thinking Type Application Volume Cube and Cuboid Based Problem Based Learning for Secondary School

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Abstract

This research aim to develop a valid and practical problem High Order Thinking Type Application Volume Cube and Cuboid based Problem Based Learning for secondary school. This is a development studies with formative evaluation type. Data collection technique include walk through, documentation, interview, test, and questionnaires. The prototype is valid qualitatively by validators that are expert. In aditonal expert have also stated that prototype is practical problem for. It has also been tested to eight grade student to know the quantitative validity and reliability of each item. This study result fifteen item exam high order thiking type application volume cube and cuboid based problem based learning for eight grade student.

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INTRODUCTION

Literacy Mathematics is often translated as the ability to apply Mathematics in various fields. Mathematical Literacy plays an important role in the digital age where information technology and knowledge develops dynamically. It shows the need for a learning approach that can shape the thinking patterns needed to interpret and critically analyze everyday situations, solve problems and evacuate the information presented to us. But the approach done by educators in schools has not been able to improve students' ability in everyday situations in solving problems. This is seen in the results TIMSS and PISA 2015 still below the average OECD that is equal to 386.

The Trends in Internationa Mathematics and Science Study (TIMSS) and the Programe for Interna- tional Student Assessment (PISA) is a test system initiated by the OECD organization to evaluate education systems from 72 countries around the world. Every three years a 15-year-old student is randomly selected to take the tests of three reading, math, and science competencies once and every 4 years for TIMSS by examining the mastery of Mathematics and science. The results of PISA and TIMSS that Indonesia has followed since 2000 have not shown good results. Indonesia still occupies the lowest position of many countries in attendance) according to Lie Thien (2015) shows that the 6 levels of ability formulated in the PISA and TIMSS studies show that almost all Indonesian students are only able to master lessons up to level 3 solving problems according to the procedure in sequence and selecting / implementing simple problem-solving strategies, while other countries involved in this case study reach level 4, 5 and 6. In PISA and TIMSS tests, Indonesian state is categorized as still at low-level thinking level that is to remember, understand and apply but not to develop high-order thinking skills that are analyzing, evaluating, and creating.

The low PISA and TIMSS results are certainly caused by many factors. According to Zulkardi (2010) the cause of Indonesian students have not been able to resolve the problem of PISA well is that students are not accustomed to work on PISA problems that are different from the usual form of questions tested in school based on real-word problem. Thus, a change in learning approach and problem-solving is needed to improve student's safety in everyday situations in solving problems.

According to Suradijono (2004), problem-based learning is a learning approach whereby students do authentic problems with the intent to develop their own knowledge, develop inquiry and higher-order thinking, develop self-reliance and self-confidence. Meanwhile, according to Yamin (2012: 17) based learning problem (problem-based learning) is one of the innovative learning models that provide active learning conditions to learners in real-world conditions. With a good learning approach is expected to improve students' high-order thinking skills.

High-level thinking according to the taxonomy of bloom is the ability that includes analysis, evaluation, and creation (Anderson, L. W., & Krathwohl, D. R, 2001). According to Heong, et al (2011) Higher-order thinking is defined as the wider use of the mind to find new challenges. This high-level thinking capability requires a person to apply new information or prior knowledge and manipulate information to reach possible answers in new situations. High-level thinking is thinking at a higher level than simply memorizing facts or saying something to someone just as something is delivered to us. Wardana (2010: 1627) argues that high-order thinking is a process of thinking involving mental activity in an effort to explore complex, conscious and creative, conscious experiences to achieve the goal of acquiring knowledge that includes the level of analytical, synthesis, and evaluative thinking . One of the most widely used mathematical materials in everyday life and including the content content domain of TIMSS and PISA is the volume of cubes and beams which is one of the geometry material. In addition, the learning objectives of cube and beam volumes that exist in the curriculum are limited to the students can calculate the surface area and volume of cubes, beams, prisms, and pyramids, but do not relate to daily life in problem solving (Curriculum, 2006). So it can be assumed that the problem of cube and beam volume in the textbook has not included the demands of problem based learning that include the ability to find conjecture, analysis, generalization, connection, synthesis, non-routine problem solving, and justification or verification.

Based on some of these opinions can be concluded that high order thinking (High Order Thinking Skill - HOTS) is a process of thinking that is not just memorize and relay information that is known. High-level thinking is the ability of students to solve new non-routine problems in exploring complex, reflective and creative experiences by using different approaches to existing tasks by linking, manipulating, and transforming existing knowledge and experience to think critically and creatively in the effort to make decisions and solve problems in new situations to gain knowledge that includes the level of analytical, evaluation, and creative thinking.

Some relevant researches include Lewy, Zulkardi, and Nyimas Aisyah (2009), which develops Problems to Measure Thinking Ability to provide results of the problems which are developed to be used to measure higher order thinking skills in Number Sequence and Series. Darwanto (2017) entitled Development of mathematics teaching materials with PBL model to develop the ability of thinking kreratif on high school students with the results of research that students class X MAN showed the average results of learning test students showed good results that is beyond KKM, and also data analysis in the form of a response indicates that learners respond well, so that the development by using teaching materials that have been developed to develop creative thinking of learners. In addition Ika Pertiwi (2016) The development of mathematical problems characteristic of TIMSS type problem solving on the topic of geometry measuring cube volumes and class VIII blocks shows that students can understand the problem well, according to TIMSS level with reliable questions of 0.7003. On the basis of this, in an effort to improve the learning process, researchers want to develop a matter of high order thingkin type of application of cube volume and block based Problem Based Learning on the subject of cube and beam volume. This research combines from some previous research, If Ika pertiwi develops math problem that focuses on the characteristic of TIMSS hence the researcher develops about high order thingking type application to know the student's mathematical literacy in the problem that is cut down characterized by high level thinking. This study is limited to the volume material of cubes and blocks, the researchers hope there will be other studies that can develop this research.

METHODS

The type of this research is design research type development study (Plomp, T., & Nieveen, N., 2009). In this study, researchers developed a matter of high order thingking type of cube and block validation of valid and practical volumes, and used to find out the mathematical litersy in the development of this problem using the stages of the popularized ADDIE (Analysis-Design-Develop-Implement-Evaluate) model in the 1990s by Reiser and Mollenda (Branch 2009)

Stage analysis is a needs assessment process (needs analysis). In this stage, the researcher analyzes the need for textbooks used by students and teachers in learning, how teachers teach, and other learning resources that teachers use in relation to study of research materials. The technique is an interview with a teacher of mathematics with the aim to know the description of the characteristics of students and know the approach taken by the teacher during the learning process.

Design stage is done after student requirement analysis, by making design (blueprint) about high order thingking type of application. The problem questioning aims to help students train high order thingking skills especially in the cube and beam volume material. The design of the problem is made on paper using the stages of Problem Based Learning (PBL) learning. The design process uses three aspects, namely: content / content, constructs, and language. That is validated by an expert. Expert advice is used for design problem revisions. The responses and suggestions from experts on designs that have been made are written on the validation sheet as material for revision.

Development stage (Development) Development is the process of realizing the blueprints into reality. That is, at this stage everything that is needed or that will support the learning process should all be prepared.

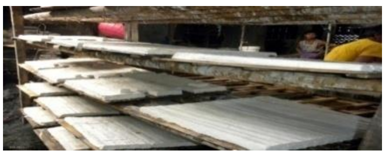
Implementation and Evaluation. At the implementation stage, the problem has been created, set in such a way as to be ready to be implemented. Prior to that, an assessment by the researchers themselves, counselors, and peers on the problem questioning were developed through problem-based learning called the first prototype.

Evaluation stage is the process to see if the problem being made is successful, in accordance with the initial expectations or not. Once the product is ready, then the problem can be piloted in a small group then evaluated and revised. Then the test can be done on large groups then reevaluated and revised so as to produce the final product that is ready to be tested on the subject of research. The evaluation stage can be done using the formative evaluation stage as follows: a) Expert Reviews. The design results on the first prototype developed on the basis of Self Evaluation given to the expert (Expert Review). This stage is named as a validity test to be evaluated in terms of content, contrast and language to the problem to be developed. b) One-to-one. The prototype was tested against three students having less, medium and high ability as a tester. This is done in the hope of seeing the practicality of design questions through observation of students in the use of questions. The results of this trial were analyzed to revise the first prototype. Prototype 1 was also validated quantitatively and given to 15 students with varying abilities. Then the researcher analyzes the items to test the validity and reliability of the saole grains. From the revision of expert review and one to one, and analysis of the item on the 15 students is called the second prototype. c) Small Group. At this stage the second prototype was tested on a group of students outside the class studied (consisting of 6 peer students non subject research). Furthermore, the results of these trials are analyzed and discussed in such a way as to produce suggestions for revision in the form of student comments on the questions. The revised result is called the third prototype. d) Field Test. At this stage the third prototype as the final product tested tehadap a class of students of SMP Pusri Class VIIIb2 as many as 21 students as research subjects. In this study is expected to see the potential effects of problems that have been developed. Products that have been tested in the field test must meet the quality criteria that is valid in terms of content, constructs, and language as well as practical which means easy to use by students.

RESULTS AND DISCUSSION

At this stage student analysis, curriculum and about the volume of cubes and PBL-based beams are developed. At all stages of the prototype, the researcher used a different class of VIII students. The goal is to avoid leakage of problems or repetition of the problem on the same student. Subsequent completion of draft initial rorotype (figure 1) of the problem to be developed. In stage one to one, researchers used 3 students of class VIIIb1 with various capabilities. Then at small group, the researcher uses 6 students of class VIIIb1 with different students and with various capabilities as well. Next in the field field test the researchers used 21 students of class VIIIb2. In this early stage also produces the instrument development tools that problem, the problem grid, problem device, problem cards, and the rubric of value.

Table 1. Problem Before Revised

Problem	Before Revised
10	An entrepreneur knows to make 10kg of tofu, if the wooden blocks are 40cm long, 40cm wide, and 2cm high, how many pieces of maximum tofu can be produced? 

Expert Review

Expert review or expert test is a validation phase of prototype 1 qualitatively in terms of content, content, constructs and language. The problem device is consulted to experts and friends who have experienced in mathematics education as a validator. The prototype 1 validator process is done through two ways: face to face review and mail / mail (mail review). Mail reviw involves one expert Sugiman, M.Si. while the face to face review of the expert involved is the teacher of mathematics at school ie Utami Yuliana, S.Pd.

One to one

One to one test is tested after expert review. about prototype 1 was tested on three students with heterogeneous ability. Students are required to work on the initial prototype. After doing the questions, students are given a questionnaire consisting of several questions about the problem that is done. The researchers then interviewed the students to confirm the questionnaire answers. In addition to validation on the expert and one to one, Prototype 1 is also validated quantitatively and given to 15 students with diverse capabilities. Analysis of the item using Microsoft Excel. Grain validation test using product moment correlation from Karl Person and reliability using Spearman Brown. Data and test result of validity of item is shown table 1.

Table 2. Test Results Validity Item Problem

Nomor Soal	r-table	r-hitung	Keterangan
1	0,482	0,806	Valid
2	0,482	0	Tidak valid
3	0,482	0,97	Valid
4	0,482	0,86	Valid
5	0,482	0,78	Valid
6	0,482	0,700	Valid
7	0,482	0,712	Valid
8	0,482	0,977	Valid
9	0,482	0,865	Valid
10	0,482	0,59	Valid
11	0,482	0,879	Valid
12	0,482	0,95	Valid
13	0,482	0,85	Valid
14	0,482	0,86	Valid
15	0,482	0,92	Valid

Based on the results of the expert review and one to one test that has been done in parallel, and the analysis of item (test of validity) quantitatively, then the matter of prototype 1 revised again and produce prototype. The result of the revision is shown in Table 3.2

Table 3. Problem prototype 2

Problem	After Revision
10	An entrepreneur knows to make 10kg of tofu, if the wooden block is 40cm long, 40cm wide, and 2cm high, how many pieces of cube-shaped tofu can be produced? 

Small Group

In the small group stage, the problem of propotype 2 is tested to 6 students. Students involved at this stage are students of varying abilities. During the process of working on the problem being done the researcher records the things that become student questions about the problem being done and researchers also interview students to find out what difficulties experienced by students. Then the students are given a questionnaire containing questions about the problem that has been done. The results of the revision of the questions based on the suggestions / comments of students in small group stage, then produced a third prototype consisting of 14 questions that will be examined at the field test stage

Field Test

In the field test stage, prototype 3 was tested on the subject of the research class VIIIb2 as many as 21 students. After working on the problem of students to inscribe students fill out a questionnaire to determine the response of students to the problems that have been done and select some students to be interviewed directly by researchers. Then, the researchers analyzed the results of students' answers to determine what potential effects arise from the problems developed by researchers. Table 3 is prototype 3 is a revision of prototype 3.2 whether the problem is revised or maintained without revision.

Table 4. Problem prototype 3

Problem	Sesudah Revisi
10	An entrepreneur knows to make 10kg of tofu, if the wooden block is 40cm long, 40cm wide, and 2cm high, how many pieces of cube-shaped tofu can be produced? 

Question number 10 is developed requires students' understanding of the information provided in solving the problem, students do the reasoning and planning an effective settlement strategy. Students are required to estimate the size of a piece of cubic shape. This problem includes simple problem solving and students can carry out the procedure well, including procedures that require decisions on a gratuity. Even the matter is classified as many students who can not solve the problem well. Here's the studentt's answer to the question of propotype 3

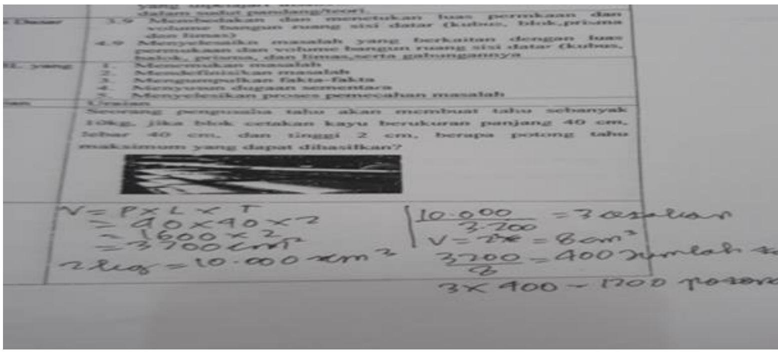


Figure 1. The student's strategy answers

To explore parts of the problem to make a conclusion. Only 34% of students can answer the question correctly.

CONCLUSIONS

Based on the results and discussion about the development of cube and block volume problems in the students of class VIII SMP, it can be concluded that the question of high order thingking type of application of cubes and blocks based on PBL is valid and practical. The validity has been tested qualitatively and quantitatively. Qualitative validation is shown from the result of the validator assessment at the expert review stage stating that the problem has been good in terms of content, constructs and language. For practicality, the experts / practitioners have stated the matter is appropriate to be given to the students of grade VIII SMP. It is also seen in the stages of one to one and small group that students can use the problem device well. The resulting field test results state that the developed problem has a potential effect on students' mathematical literacy skills in high-level thinking.

Based on the results of the research and conclusion, then if the results of this study can be input for other researchers in developing a matter of high order thingking type application of cubes and PBL-based blocks for junior high school students.

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