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The Development of Learning Devices Based Realistic Approach for Increasing Problem Solving Mathematics Ability of Student in SMPS Gema Buwana

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Abstract

This type of research was a of learning devices with the aim to produce devices based learning approach that was valid realistic mathematics, practical and effective, and all the instruments of research related to the application of these devices in the learning of mathematics on the subject of rectangle and square for seventh grade students of SMP. This study was conducted in two stages, namely the first stage was the development of learning tools. The development of devices based learning mathematics realistic approach with reference to the development model learning device according to Thiagarajan, and Semmel Semmel ie 4-D models (four D models). The second stage was the implementation of learning devices that were considered feasible. The design of the trials was a one-group posttest-only design. The findings of the research were: 1) the resulting learning, such as: lesson plan, student books, student activity sheet, and test problem solving had met the criteria of good / valid; 2) The effectiveness of the learning device inferred based on: (i) complete student learning classical at the first trial amounted to 85.17% and in the second test by 90%, (ii) achievement of learning goals at the trials I was not achieved in a matter of question number 3 and 4 and no trial II was reached on each item, (iii) the performance of the ideal time at the trial I and II trials were ideal, 3) The student's response to the component and learning activities was postive.

Keywords: *Learning devices, Realistic Approach, 4-D Development Model, Problem Solving Mathematics ability.*

1. Introduction

Problem solving is not simply a process that ends when an answer is found; it is a scientific process that evolves from understanding the problem to evaluating the solution. In traditional teaching, assessment of whether students had understood a mathematical problem was based on whether they could describe the correct arithmetic procedure. However, it was not enough to evaluate students' mathematics concepts and abilities of solving math problems merely depending on their writing.

Mathematics lessons at Junior High School level have four aspects of study: numbers, measurements and geometry, opportunities and statistics, and algebra. Nurhasnah et al (2014: 29) "Building a particular flat rectangle is one of the mathematical matter that is closely related to real life. Students are familiar with the shape of the rectangle because it has been taught at the level of the previous class for example in kindergarten ". Bell (in Khoiri, 2014: 262) Geometry as one of the branches of mathematics studied by junior high school students is not the first time. This condition should be an experience for students in learning geometry towards a more complex with basic skills that have been owned.

The facts in the field Rudtin (2014: 18) after conducting tests to identify problems related to the story of the material on the circumference and the area of rectangle in Class VIII academic year 2012/2013 SMPN 7 Palu. Based on the results of the test followed by 29 students, it was found that 19 students did not answer about the test given. This is because they do not understand the meaning of the problem.

The development objectives of curriculum 2013 undertaken in Indonesia are to change the learning process of students who are notified to be students who find out, the process of assessment from output-based to process-based and output and balance softskill and hardskill. One that is demanded in the curriculum of 2013 and 21st century competence must be built is the problem-solving ability.

The importance of this problem solving abilities are also expressed by According to Ranjan and Chandra (2013) Problem solving significantly plays a important role in mathematics teaching and learning. Trough problem solving students can enhance reviews their thinking skills, apply procedures, deepen reviews their conceptual understanding ". Meaning problem solving plays an important role in learning mathematics. With problem solving, students can improve their thinking skills, apply procedures, and deepen their conceptual understanding. Liljedahl, et al. (2016) says mathematical problem solving has long been viewed as an important aspect of mathematics, mathematics teaching, and mathematics learning. The more people who want to help solve the problems of others, the more the person's chance to use high-level thinking when thinking in solving scientific problems (Gallagher et al. 2012).

The current reality shows that the achievement of students in math lessons is low and has not met expectations. The low ability of students and mistakes of students in solving mathematical problems can we know from some research results. Research conducted by Nuroniah et al (2013: 27) obtained the result that the tendency of mistakes made learners almost evenly for each given problem, and the tendency of the most prominent error that is erroneous data error, inappropriate procedures and hierarchy of skills. The cause of the error occurs because students have no skills to solve the problems of mathematics, as well as the invisibility of numerical manipulation skills so as to give the conclusion that the ability of the problem of students is still low.

Based on the results of discussions with private Gema Buwana Junior High School teachers before conducting this research, students often make mistakes looking around the rectangle and square, for example by multiplying the length of the sides of the rectangle.

There are many ways to develop student’s problem solving abilities, among others, teachers spur students to be able to think logically by providing problems of application in accordance with daily life which is then changed in the form of mathematics. The use of realistic approach in mathematics learning can be one of the means to develop student problem solving abilities. To improve problem-solving skills, it is necessary to develop problem-solving skills, create mathematical models, solve problems, and interpret the solutions. Mavugara (in Nizar Rangkuti, 2015: 73) suggests that in order to strengthen students' skills in problem solving, mathematics teachers need to take advantage of real issues that are open-ended ie real issues that have many ways to answer or many answers. Through an open-ended problem students learn how to practice in their own way and at the

same time practice to understand the way other students use it. In a realistic mathematical approach such real issues are used as the beginning of learning which is further utilized by the students in the mathematical process and the development of the mathematical model.

Murniati et al (2013: 114) obtained the result that the learning tools of realistic approaches developed are effective for use and can improve student's problem-solving abilities. From the description and the results of this study clearly show that the realistic approach is a suitable approach and can be used as an alternative learning in the process of improving students' mathematical problem solving ability.

Learning tool is planning to be implemented in class, hence learning device oriented realistic approach expected can become alternative to create good learning and expected able to improve problem solving ability and student learning independence. Along with that, learning tools that use realistic approach has not been developed.

Based on the above description, the problem to be studied in this research is how: (1) the effectiveness of learning tools developed using realistic approach to the ability of problem solving mathematically; (2) improving students' mathematical problem solving abilities of learning tools developed using realistic approach; (3) students' responses to learning using learning tools developed with a realistic approach.

2. Literature

2.1.Problem Solving Mathematics Ability

Problem solving is one of major aspect in mathematics curriculum which required students to apply and to integrate many mathematical concepts and skills as well as making decision. However, students were reported to have difficulties in mathematics problem solving (Tambychika, Subahan and Meerah: 2010)

Lesh and Zawojewski (Kuzle: 2013) defines "mathematical problem solving as the process of interpreting a situation mathematically, the which usually involves Several iterative cycles of expressing, testing, and revising mathematical interpretation and of sorting out, integrating, modifying, revising or refining clusters of mathematical concepts from various topics within and beyond mathematics ".

Vettleson (2010) said, "in the discipline of mathematics, the use of problem solving skills has been extremely important and highly influential. Problem solving is the foundation of all mathematical and scientific discoveries ". In the disciplines of mathematics using problem solving skills have a very important influence. Problem solving is the foundation of all mathematics and the process of discovering new knowledge.

Students can learn to become better problem solvers . Polya (1981) presented four phases or areas of problem-solving, which have become the framework often recommended for teaching and assessing problem-solving skills. The four steps are: (1) understanding the problem, (2) devising a plan to solve the problem, (3) implementing the plan, and (4) reflecting on the problem.

From the opinions above, can be concluded that the mathematic problem-solving ability is ability of the student to solve problems by observing the process of finding answers based on the step-by-step problem-solving: 1) understand the problem, 2) planning, 3) performing the plan, and 4) confirmation the answer.

2.2.Realistic Approach

The meaning of the mathematic concept is the main concept of RME. The students‟ learning process is only happened if the learned-knowledge is meaningful to students (Freudenthal in Wijaya, 2011) A knowledge will be meaningful if the learning process is held in a context (CORD In Wijaya) a realistic process the learning uses realistic problem. A realistic problem is not just a real-world problem and can be found on students‟ daily activities. A problem called „realistic‟ if the problem is imaginable or real in students mind. Webb et al (2011) said that: "it is important to point out here that the realistic aspect of RME is not just because of its connection with real-world context, but it is related to the emphasize that RME puts on offering students problem situations which are imaginable.

Treffers (1987) distinguished two kinds of mathematical horizontal mathematic refers to experiantially real situations into mathematics and vice versa, where as vertical mathematization refers to process of attanting a higher level of abstraction within mathematics. Next, according to Freudenthal (1991) stated it in the following way: "horizontal mathematization involves going from the world of life into the world of symbols, while vertical mathematization means moving within the world of symbols"

3. Research Method

The research method is the development research to the teaching material through 4-D model by Thiagarajan, Semmel and Semmel. The researcher had developed the teaching material in social rectangle and square material. The learning tools developed in this research is teaching material through realistic approach. The developed model which is stated by Thiagarajan, Dorothy S. Semmel, dan Melvyn I. Semmel (1974:5) [10] include of four step called define step, design step, develope step and the disseminate step.

3.1. Population and Sample

The population in this research were all students of class VII Buwana Private Gema. Sampling in this research using purposive sampling. The class that used as the sample of this research is class VII-4 Gema Buwana Junior High School and VII-2 class of Gema Buwana Junior High School. The reasons and considerations in the selection of samples of the class sampled have the same characteristics seen from the time of its learning, characteristics of students, and the material studied.

3.2.Development of Learning Devices

Development of learning devices includes: Student's Book, Lesson Plan, Student Activity Sheet, and research instruments are problem solving ability test.

3.3. The Instrument and Data Analysis Techniques

The instrument or tool for collecting data in this research is test, questionnaire and observation sheet. The test is used to measure the problem solving mathematics ability. The questionnaire used to collect student responses, and the observation sheet used as a sheet observation on the implementation of the developed learning devices in the classroom.

Before the tests used in the trials I and II trials, first tested the samples outside the

classroom, then the test results are analyzed validity and reliability. The formula used to calculate the validity is product moment correlation formula (Sugiyono, 2013), namely:

$$r_{xy} = \frac{N\sum_{i=1}^{N} X_i Y_i - \left(\sum_{i=1}^{N} X_i\right)\left(\sum_{i=1}^{N} Y_i\right)}{\sqrt{\left\{N\sum_{i=1}^{N} X_i{}^2 - \left(\sum_{i=1}^{N} X_i\right)^2\right\}\left\{N\sum_{i=1}^{N} Y_i{}^2 - \left(\sum_{i=1}^{N} Y_i\right)^2\right\}}}$$

Description

r_{xy} = coefficient of correlation between the variables x and y

x = score acquisition of items

y = total Score

N = number of students

a. Achievement of learning purpose

Achievement of learning purpose for each item used formula :

$$T = \frac{total\ score\ of\ students\ for\ items\ to{-}i}{total\ maximum\ score\ item\ to{-}i} \times 100\%$$, (Fauzi, 2002:10)

The criteria are:

0 % ≤T< 75 % : Learning purpose not achievent.

75 % ≤ T ≤ 100 % : Learning purpose achieved.

a. Data Analysis Mathematical Problem Solving Ability Test

The effectiveness of instructional device related to mathematical problem solving ability is determined based on the students' achievement in classical learning. Minimal completeness is analyzed by considering that students can be said if the value of students individually reach ≥ 75%. Student scores are individually determined by the following formula:

$$\text{Student scores} = \frac{\text{Scores obtained}}{\text{Maximum score}} \times 100\%$$

Furthermore, a learning is said to have been completed in a classical manner that is ≥ 85% (Trianto, 2011: 241) students who take the test have achieved a minimum score of 75. Percentage can be calculated by the formula:

$$PKK = \frac{\text{Number of Students Completed learning}}{\text{Total number of students}} \times 100\%$$

b. The achievment of ideal time

Achieving the ideal learning time is at least the same as regular learning.

c. Analysis of Student Response Data

The result of questionnaire of student response is analyzed by presenting the positive and negative responses of students in filling out the student response questionnaire which is calculated by the formula:

$$PRS = \frac{\sum A}{\sum B} \times 100\%$$,Borich(Herman, 2012: 5)

Description:

PRS : The percentage of many students who responded positively to each of the categories asked

$\sum A$: The proportion of students who choose

$\sum B$: Number of students (respondents)

To determine the achievement of learning objectives in terms of student responses, if the number of students who responded positively was greater or equal to 80% of the many subjects studied for each trial (Sinaga, 2007: 171).

4. Result

4.1. The Description of Development of Learning Devices Based Realistic Approach

Development of learning devices is done by using 4-D model of which consists off our stages of development that define, design, develop, and disseminate. In detail the stages of development of learning devices as follows:

4.1.1. Define stages

a. Front end analysis

The fact shows that so far the teacher does not yet have a good learning device. As the implementation lesson plan used is not an illustration of the learning process implemented, it does not use student activity sheets and student books that are still general, which does not explain what competences will be improved on each learning material.

b. Students analysis

Student analysis includes cognitive development and academic background skills. The analysis of students' knowledge in class VII Private Junior High School Gema Buwana is on average 11-13 years old, students are in formal operation stage or they have been able to think abstractly.

c. Concept analysis

The lesson material used in this research is rectangular and square material for VII class students of Gema Buwana Junior High School with reference to Curriculum 2013. Analysis of the concept related to the analysis of the material that will be studied by the students, namely by creating concept maps that will facilitate students in understanding the material lesson. The concept map is then adapted to a realistic approach. The resulting concept maps are then placed on student books.

d. Task analysis

Task analysis is performed to identify the stages of completion of tasks that students do at the time of learning that refers to the analysis of the concept. The tasks that will be done in accordance with the tasks in the textbook of students include: the task to check the initial understanding by answering contains the test of the student's initial ability. Students read each of the instructions in the book to make it easier to learn rectangular and square material that can hone students' skills after reading the rectangular and square concepts.

e. Formulation learning purpose

Learning objectives are tailored to core competencies and basic competencies in accordance with the curriculum 2013. Formulation of learning objectives is a reference in designing learning tools using a realistic approach. Indicators / learning objectives are tailored to the core Competencies and Basic Competencies of the 2013 curriculum.

4.1.2. Design stages

a. Test compilation

The test in question is a problem-solving test of mathematical material rectangular

and square.

b. Media election and tools

The result of media selection is adjusted with the result of task analysis, concept analysis and the characteristics of students Gema Buwana junior high school. Media and tools learning material of rectangular and square teaching aids are origami paper, pencils, rollers, scissors, cork board and power point.

c. Format election

The lesson plan format used adapted to the lesson plan format in the K13 curriculum, the learning activities consisting of preliminary activities, core activities and cover. While the Student Book format and student sheet activity are made colored so that students will be interested and motivated to learn.

d. Preliminary design

At this stage the initial draft of the lesson plan is planned for 4 meetings, teacher manual for each meeting, student book and student sheet activity for each meeting, concept comprehension skills test, mathematical disposition scale, scoring guide, and answer key. All the results at this design stage are called Draf-I.

4.1.3. Develop stages

The results of define and design stage resulted in the initial design of a learning tool called draft I. After the learning devices based on realistics approach designed in form draft I, the validity test of the expert review and field trials were conducted.

a. The results of the validation expert

Before learning tools and research instruments are piloted, first learning tools and research instruments are validated to five validators including experts in the field. From the validation results, the learning device criteria and research instruments developed are "valid" and can be used with small revisions. Furthermore, the research instrument is a test of students' mathematical problem solving skills, first tested in the class outside the sample, then tested the validity and reliability.

b. Trials I.

Once the learning device developed has met the valid criteria. Then the next learning device in the form of draft II is tested in place of research that is test I conducted in class VII 4 SMP Swasta Gema Buwana. The result of data analysis of trial I is the learning devices has not been effective, because there are still some indicators of effectiveness that have not been reached. The result of classical mastery of students' mathematical problem solving ability on trial 1 can be seen in table 1.

Table 1. Description of Mathematical Problem Solving Test Results

No	Description	Value
1	Top Value	85
2	Lowest Value	35
3	Average	75,43
4	Persentage of Mastery Clasikal	85,71

Achievement of learning objectives on the result of post test pilot I is not yet achieved that is on item 3 and number 4. While the learning time used has been in accordance with the criteria of learning achievement.

Based on the results of analysis and trial I, it is necessary to revise some learning

device components developed in the hope that learning deviced based on realistic approach can improve students' mathematical problem solving abilities.

c. Trials II.

After conducting draft I in draft II, further improvements are made to produce instructional deviced that meet the good effectiveness. The result of revision in trial I produced draft III which will be tested on VII-2 students of Gema Buwana Junior High School. The second trial was conducted four times in accordance with the implementation lesson plan that has been developed. Trial II was conducted to measure the effectiveness of learning deviced (draft III) developed based on realistic approach which aimed to improve students' mathematical problem solving abilities. Overall, the classical completeness level of students' mathematical problem solving abilities in trial II can be seen in table 2.

Table 2. Description of Test Results of Mathematical Problem Solving Ability

No	Description	Value
1	Top Value	95
2	Lowest Value	60
3	Average	81,17
4	Persentage of Mastery Clasikal	90

The table 2 shows that the result of classical completion percentage of problem solving skills 90%, it is stated that the students have fulfilled the classical completeness value with many complete students as many as 27 people and students who are not complete as many as 3 people.

Achievement of learning objectives on results post test II has been achieved on each item. Likewise, the learning time used has been in accordance with the criteria of learning time attainment. Thus it can be concluded that the learning tools based on realistic approach in trial II which is a revision of trial I have met the quality of effective learning devices.

4.1.4. Disseminate stages

The dissemination of learning devices based on realistic approach in this research is done only limited to partner schools only that is Gema Buwana Junior High School from material, class / student and time (special deployment). After the final device, the developed learning devices are deployed for use in the following year in rectangular and square materials.

4.2. Discussion of the Development of Learning Devices Based on Valid and Effective Realistic Approach

In developing the learning devices using Thiagarajan, Semmel and Semmel development model is done through 4 stages which furthermore known by 4D abbreviation is define, design, develop, and disseminate. The end of this development is to produce products in the form of learning devices that include student books, student activity sheets and learning execution plan and its instruments. But in developing this learning devices must be tested its quality, such as its validity and effectiveness.

The following will summarize the results of the validation assessment of the expert team.

Table 3. Summary of Validation Results

No	Learning Device Components	Avg. Validation Value	Category
1	Student Books	4,26	Valid
2	Student Activity Sheet	4,05	Valid
3	Lesson Plan	4,25	Valid

The Table 3 shows that the validation results for each learning device components developed by using a realistic approach is in the category "valid" with the average value of each component is 4.26, 4.05, and 4.25. But even though the learning device components developed meet the criteria of validity, there are several things that need to be fixed in accordance with the notes provided by the expert team covering the use of language, writing or typing, display images that must be in accordance with the conditions and clarified. The results of note from the expert teams that this learning device has met the criteria of validity with the category "valid" with a slightly revised note.

4.3. The Effective of Learning Devices Based Realistic Approach

In determining the effectiveness of a developed material show that from three aspects of the results of classical completeness, the achievement of learning goals and the achievement of the ideal time. The following will present a discussion for each indicator in measuring or looking at the effectiveness of learning device based on realistic mathematics approach.

a. Classical Completeness

The table 1 shows that the classical completeness obtained during the first trial of 35 students of 85.71% and in the second trial with 30 students by 90%. Overall this achievement has fulfilled the criteria of classical completeness that is at least 85% of the total students complete with a value of 75. The following will be described the number of students who achieve completeness for each meeting in first trial and second trial.

Table 4. Number of Completed Students on Trial I and Trial II

No	Information	Trial I	Trial II
1	Completed	30	27
2	No Completed	5	3
	Total	35	30

In case viewed from the results of students' learning completeness individually and classically it can be concluded that the learning tools based on realistic mathematical approach has met the criteria of effectiveness, so that this learning device has been effective for use in learning.

b. Evidence of Learning Objectives

Based on the criteria of achievement of student learning objectives on the results of first trial in question number 1 about result postes is equal to 75.71%. Achievement of learning objective on problem number 2 result postes is equal to 91,43%. Achievement of learning objective on problem number 3 result postes is equal to 67,86% And the achievement of learning goal at problem number 4 result postes is 46,43%.

In accordance with the achievement of learning objectives that is said to be achieved with criteria ≥ 75% of the maximum score for each item. Thus the achievement of the learning objectives in the student postes results is not yet achieved that is on the question number 3 and number 4.

The Second trial, based on the criteria of achievement of student learning objectives on problem number 1 result postes is equal to 79.17%. Achievement of learning objective on problem number 2 result postes is equal to 91,67%. Achievement of learning objectives on problem number 3 results postes is 78.33% and Achievement of learning objectives on problem number 4 result postes is 75.83%.

In accordance with the achievement of learning objectives that is said to be achieved with criteria ≥ 75% of the maximum score for each item. Thus the achievement of learning objectives on the student's post results is achieved on each item.

c. Achievement of the ideal time

From the results of ideal time achievement in each meeting for first trial and second trial in using learning device based on realistic approach obtained the ideal learning time that is learning that is done on the development of device based on realistic approach same with usual learning. In the experimental study I and experiment II learning was conducted four times meeting that is meeting I learning material rectangular properties and determine the circumference of rectangle meeting II learning material determine the area of the rectangle, meeting III learning material the properties of square and determine the circumference Square and meeting IV learning materials determine the square area.

4.4. Improvement of Student Mathematical Problem Solving Ability by Using Learning Deviced Based Realistic Approach

Based on result of test first trial and second trial, the result of student test on mathematical problem solving ability. In first trial conducted in VII-4 grade Junior High School of Gema Buwana obtained average student score of 75.43 and learning completeness of 85.71%. Furthermore, in second trial in VII-2 grade Junior High School of Gema Buwana obtained average student score of 81.17 and learning completeness of 90%.

Based on the average of both trials, it shows that students 'mastery of students' mathematical problem solving skills increased from trial I to trial II. Increase occurred at 5.74 points and by 4.29% increased learning mastery. So based on the results of tests given show that the learning tools based on realistic approach developed to give a positive response and influence on student's learning mastery, especially on students' mathematical problem solving abilities.

a. Result of Student Response Questionnaire

The following will be presented in the result of questionnaire of student response on field first trial and field second trial.

Table 5. Average Percentage of Student Response

No	Aspect	Trial I	Trial II
1	Happy statement to learning device components	95,43%	93,33%
2	A new expressions of learning device components	90,29%	89,33%
3	Expressions of interest in the learning device component	94,29%	93,33%
4	Expressions easily understand the components of the learning device	90%	93,33%
5	Interest Expressions in learning device components	92,86%	89,99%

The Table 5 shows that the student response on first trial and second trial of learning device components developed by using realistic approach meet the criteria of positive response.

5. Conclution

Development of learning device based realistic approach using Thiagarajan, Semmel and Semmel development model is aimed to improve students' mathematical problem solving ability at Gema Buwana Junior High School. From the results of research that has been done then the conclusions that can be described in this study are:

a. Effectiveness

Based on the indicators of effectiveness are: 1) classical learning completeness in the first trial I get a percentage of classical completeness of 85.71% it is stated that students have fulfilled the classical completeness value and in the second trial by 90% it also states that students have met The value of classical completeness; 2) the achievement of the learning objectives of the first trial on problem number 1 of 75.71%, the achievement of the learning objectives on the question number 2 of 91.42%, the achievement of learning objectives on problem number 3 of 67.86% and the achievement of learning objectives on the question number 4 by 42.43%.

In according with the criteria of achievement of learning objectives that said reached the criteria above 75% of the maximum score for each item. Thus the achievement of learning objectives on the results of postes trial I is not yet reached that is in item number 3 and number 4. Furthermore, in the first test is not achieved in item 3 and number 4. Furthermore, in the second trial the achievement of student learning objectives At number 1 of 79.17%, Achievement goal achievement of learning objectives on problem number 2 of 91.67%, the goal achievement of learning objectives on problem number 3 of 78.33% and goal achievement of learning objectives on problem number 4 of 75.83 %. Achievement of learning objectives on post test II results has been achieved on each item; 3) From the achievement of ideal time in each meeting for first trial and second trial in using learning devices based on realistic approach obtained the ideal learning time that is learning that is done on the development of device based on realistic approach same with usual learning. So the learning device with realistic approach is feasible for use in learning mathematics of rectangular and square material.

1. Mathematical problem solving ability of students has increased.
This can be seen from the percentage of students' classical completeness in the first trial of 85.71% and the second trial of 90%.

2. Student response shows a very positive response with a percentage above 80%.

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