Development of learning devices based on problem based learning to improve the problem solving ability at grade VII of SMP

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Abstract. The aims of this research was to produce the learning devices based on a valid Problem-based learning (PBL) to improve the students’ problem solving ability. They are lesson plan and students’ worksheet. for grade VII SMP. PBL aims to involve students in solving problems using real-world problems as a context for students to learn through problem solving ability. Learning devices using a PLOMP Model consist of three stages: the preliminary investigation phase, the development phase and the evaluation phase. Learning devices are said to be valid if they meet the validity of content and construction. The result of research known that instrument used is a validation sheet containing the presentation aspects, content worthiness and material, graphic and language. Expert validation results show that learning devices meet valid criteria.

1. Introduction
One of the mathematical abilities that can improve students’ math abilities, including problem solving abilities. Problem solving capabilities require a directional thinking process to generate ideas, ideas or develop the possibility of resolving the problems encountered. The problem-solving process gives students the opportunity to engage actively in learning, searching, discovering their own information to be processed into concepts, principles, theories or conclusions.[1]

Problem solving is part of the mathematical curriculum which is very important because in the learning process, the students are possible to gain experience using the knowledge and abilities already possessed to be applied and delivered both orally and writing. Problem solving includes understanding the issue, planning a completion strategy, implementing a problem solving strategy, checking the results again. Therefore, problem solving is a high level of intellectual activity, so it can help students to take the initiative and think systematically in dealing with a problem by applying the knowledge gained previously.[2]

Based on the results of observations conducted in SMPN 27 Kerinci obtained the information that the problem in the student worksheet is still too mathematically. The problem in student worksheet does not known does not include a mathematical ability in particular about problem solving capabilities. As a teacher with a major role in the learning process, there is an effort to create an effective learning environment to improve students’ problem solving abilities, namely the development of teaching materials. A teacher should be able to develop teaching materials because through the development of teaching materials will be more helpful in achieving the competence of students.[3]

To overcome these problems, teachers are required to make learning to be more innovative by developing a problem-based mathematical learning device that can overcome the development of
student problem solving ability in Solving a problem. One of the learning models that can be developed is to use problem based learning (PBL) models. The PBL is a learning approach by making confrontations to students with practical or learning issues that begin with problem-giving and having context with the real world [4]. This Model trains the students to solve problems with the knowledge it possesses. The process will create new knowledge that is more meaningful to students. Learning devices are based on problems, with the result that implementing learning based on problems gives better learning outcomes. The PBL devices is expected to open up the horizon of thinking, developing ideas, and enhancing the creativity of the students' thinking. [5]

Based on the description of the problem that has been showed, so the researcher do the research to produce the mathematic learning devices based on problem based learning that meets the criteria of validity, practicality and effectiveness. The effectiveness of learning devices is seen from the students’ problem solving abilities. The problem solving indicators used are (1) identifying given asking for and sufficiency of necessary elements, (2) Formulating mathematical problems, (3) implementing strategies to resolve problems and (4) recheck the solution.

2. Methodology
This type of research is development research. The model of development used in this study was the PLOMP model. The Model Plomp consists of three phases, they are the preliminary investigation phase, development or prototyping phase, and evaluation phase [6]. The instruments used in this study include questionnaire, observation sheets, interview guidelines, Field notes, and tests. Before used, each instrument is validated by an expert. A valid instrument is used in the study.

Data of research results are analyzed according to data type. Qualitative data is analyzed in a qualitative way and quantitative data is analyzed and categorized so that it can be taken into a qualitative conclusion.

3. Finding and Discussion
The following results are gained based on the research that has been implemented and it’s implementation process.

3.1 Preliminary investigation phase
The initial investigation phase is implemented in order to determine the shape and characteristics of the learning device to be developed. This phase is carried out several activities such as need analysis, curriculum analysis, student’s analysis and concept analysis.

3.2 Needs analysis
Based on the need for analysis, some teachers have do effort to implement learning models that can motivate and enable students in the learning process. But learning objectives are still not achieved because of low problem-solving abilities. Some of the obstacles encountered by students seemed to be confused in solving problems that were in the form of story questions. To answer the students’ problem solving immediately related to the formula, and directly apply the formula it knows.

3.3 Needs analysis
Based on curriculum analysis, researchers studied the curriculum used in SMP Negeri 27 Kerinci, namely 2013 curriculum, especially in algebraic material, equation and linear inequality of one variable, and the ratio of grade VII SMP. In this analysis also, observe and improve the achievement of competencies in learning devices. It is related to organizing the material and determining the learning objectives that will be achieved at each meeting. Analysis of the curriculum in question is analysis of the formulation of indicators achievement of the competency of algebraic material, equation and linear inequality of one variable and the comparison indicated on the syllabus. There are no changes to the designated core competency and basic competency but there is a change in the formulation of the indicators in the material.
3.4 Student Analysis
Based on the students' analysis, some information is used as the basis for the design of a learning device based on Problem (PBL). Information on students' academic abilities is obtained by providing tests tailored to the problem-solving ability indicator. From the test, it appears that the students' problem solving abilities are low.

3.5 Concept Analysis
The concept analysis aims to determine the content and subject matter needed in the development of learning devices. Material is indispensable for achieving the competency achievement indicator. After learning the material that is learned in the form of algebra, linear Association of one variable and comparative, it is necessary to analyze the concept in order to identify the key concepts to be taught and to organize them systematically according to In the order of presentation. After analyzing the concepts based on the curriculum used there are 3 chapters namely the form of algebra, a system of linear equations one variable, and comparisons.

3.6 Prototype Development phase
The purpose of this development is to produce math learning devices for students of Grade VII SMP on alajbar material and a problem-based comparison that is valid, practical and effective. Once the learning indicators are formulated, and the main concepts are established through need analysis, curriculum analysis, concept analysis and student analysis conducted at the initial investigation stage, then can be designed learning devices As needed. In the development planning, outlined several results from the learning device that will be developed namely LESSON PLAN and Student Worksheet based on PBL. The following will be outlined the characteristics of the built-in LESSON PLAN and Student Worksheet based problem solving.

3.6 Design Results of Lesson Plan and Student Worksheet
Once the learning indicators are formulated and the main concept is set then the next step is designing learning devices. The following will be outlined For Pbl which based lesson plan and Student Worksheet characteristics.

3.7 Lesson Plan Design
Lesson Plan serves as a guideline for teachers in delivering learning materials. Lesson plan is systematically designed which contains the writing components of Lesson Plan listed on Permendiknas No 22 year 2016. The learning activities presented in the lesson plan refer to the PBL-based learning Integrated in the PBL-based Student Worksheet. Presentation of lesson plan identities, competency standards, basic competencies, competency achievement indicators, learning objectives, materials, methods, media, learning resources; learning steps, and assessment of learning outcomes. lesson plan components that characterize the Problem based Learning lesson plan, among others, can be examined in the steps of learning activities. Learning activities on lesson plan-based Problem Based Learning.

3.8 Student worksheet Design
The Student Worksheet is designed to help students to construct, find their own learning materials based on their competency achievement indicators. The language used in this Student Worksheet is Bahasa Indonesia according to the perfected spelling (EYD). Orders and questions on Student Worksheet are arranged with clear sentences so as to direct students to activities and answer questions well. Student Worksheet size is adjusted to the size of Student Worksheet, which is commonly used by students, size HVS A4. The type of writing used in the preparation of Student Worksheet is Comic Sans MS. The presentation of Student Worksheet consists of instructions on the use of Student Worksheet, core competencies (KI), basic competencies (KD), indicators and objectives.

3.9 Self Evaluation Results
The result of a learning device design called prototype 1 performed a self evaluation in advance of the learning device that was designed before it was validated. There are three main aspects that are evaluated
on lesson plan, the typo, the completeness of the lesson plan component, and the accuracy of the text size. In Student Worksheet, the aspects evaluated are the accuracy of typing, the accuracy of the use of words and terms, the accuracy of the use of punctuation, accuracy of text size, accuracy in image placement, availability of place for problem solving. In general, many errors occur in Word typing and punctuation.

After self-evaluation, a revision of the learning device is performed. Then the results of Prototype 1 are consulted and discussed with experts or experts who are competent to be validated.

3.10 Learning Device Validation Results
The validity test of the PBL-based learning device was conducted by 5 validators consisting of 3 mathematics education experts, 1 education technology expert, and 1 Indonesian language expert.

3.11 Lesson plan Validation Results
In lesson plan, the observed aspect is the identity of lesson plan, competency achievement indicators, learning objectives, teaching materials, models, approaches, strategies and learning methods, learning activity measures, learning resources, assessment, language and benefits of lesson plan.

Overall, the lesson plan developed is said to be very valid with an average of 89.58%. So, it can be concluded that lesson plan of mathematics-based PBL for students of grade VII SMP has been valid.

3.12 Student Worksheet Validation Results
Based on the input from the validator, a revision of Prototype 1 Student Worksheet was implemented. Before being validated there is still a problem with the Student Worksheet. Improvements performed on Student Worksheet based on the suggestion of the validator are unsuitable issues replaced. Improvements to the issue are also followed by the improvements to the illustration image used.

After the revision of Prototype 1 Student Worksheet, the Student Worksheet was again handed over to the expert to be validated. Based on the validation obtained that on the presentation and eligibility aspects, Student Worksheet obtained a validity value of 91.66% or in a very valid category. So it can be said that the developed Student Worksheet has been valid in terms of content presentation and eligibility. Furthermore, the results of validation Student Worksheet by an education technology expert acquired the validity value of 80% that is in the category is very valid. It is stated that Student Worksheet has been valid in terms of graft. The intermediate value of the Student Worksheet validation by the linguist is 100% which is in a very valid category. So it is known that on the aspect of Grafikaan, the developed Student Worksheet is valid. Overall, the average validity value of the fifth Student Worksheet Validator is 90.55% which is in a very valid category. So it can be concluded that Student Worksheet-based problem-solving mathematics for students of grade VII SMP is being developed valid. The revised and valid prototype 1 Student Worksheet is next named Prototype 2 Student Worksheet.

3.13 Individual evaluation result (One to One Evaluation)
The evaluation of one-on-one Prototype 2 learning devices was conducted at the research Test School in the state Junior high School 27 Kerinci. Students who are subject to evaluation of one-on-one Student Worksheet consist of three people with different abilities namely moderate, low and high ability. The evaluation of one-on-one Student Worksheet is implemented in order to identify possible mistakes such as grammar that are poorly understood by students, less obvious instructions, ease of use, frankiness, and satisfaction.

Based on the observations conducted by researchers on the implementation of one to one evaluation, starting on the first day until the ninth day and the interview of three people, Student Worksheet Used by students easy to understand and work on. Although there is little improvement. This is in accordance with the theoretical study that a device can be said to be practical if it can be used and understood easily. Through the interview activity is very clear that the presentation in the Student Worksheet can easily understand both the instructions in the Student Worksheet, images, context of the problem of the field of expertise, as well as the results of the given tests can be said to be practical.
3.14 Result of small group Evaluation
Prototype 2 learning devices were tested in a small group consist of 6 students of grade VII Junior high School, 27 Kerinci. The goal of small group evaluation is to identify the lack of learning devices. Small group evaluations are carried out by carrying out real learning, only with limited students. After learning, students are asked to fill a questionnaire to see the practicality or implementation of learning devices. In addition, due to time constraints, the problem is done by students at home as a homework because time is not enough to work in the school. While the improvement in Student Worksheet is implemented there is one question that the intent is poorly understood by the students. After the implementation of the learning all meetings are completed, then researchers ask students to be interviewed to see the practicality of learning devices. From the interviews it can be concluded that Student Worksheet has been able to be used by students in learning. Learning Devices (LESSON PLAN and Student Worksheet) that have been revised based on deficiencies found at the time of the small group evaluation are named Prototype 3 learning devices consisting of Prototype 3 lesson plan and Prototype 3 Student Worksheet.

3.15 Effective Small Group test
A small group's effectiveness test was conducted to see improvements in problem solving capabilities through PBL-based learning devices for small groups. The tests/problems used to measure problem solving abilities in the small group are the same as the tests/questions used for test fields but different forms of question. The reason researchers use the same form of question as the test field is because the problem in the test field has been validated by experts. The problems provided are about problem solving questions and the usual questions.

The test result of problem solving capability on small group for algebraic form material gets 83.33% and ratio 83.33% then can be said effective.

3.16 (Field Test) test results
Based on the teacher's questionnaire after learning in the assessment phase, the practical value of learning devices is 93.75% which is on very practical criteria. So it can be concluded that learning devices have been able to be implemented and used well by teachers in learning.

Furthermore, the value of lesson plan is based on observation. From the observation results obtained the practical value of lesson plan by the teacher is 91.17% who are in very practical category. From the data obtained, both through the questionnaire and observation obtained the same results, namely learning devices especially lesson plan has been practical. So it can be concluded that the learning activities in lesson plan have been able to be implemented well by the teacher in learning.

Based on the questionnaire filled by the students after the study in the assessment phase obtained the value of practical Student Worksheet is 83.23% that is on the criteria very practical. From the data obtained, either through the questionnaire or observation obtained the same result, namely Student Worksheet has been practical. So it can be concluded that the activities of learning in the Student Worksheet have been well implemented by students in learning.

3.17 The effectiveness of learning device in the Problem Based learning
The effectiveness of the PBL-based mathematical learning devices that have been developed are seen by conducting tests to determine students’ problem-solving abilities. The instrument used is a matter of test essay. Based on the test results that have been carried out with the scoring of students’ problem solving abilities, the average value of the final test value of the student problem-solving capability is 82.56 and 20 students have 16 people or 80%. Based on the test result data that the learning device developed has been effective. It can then be concluded the use of effective problem solving-based mathematical learning devices to improve student problem-solving abilities.

4. Conclusion
Based on the process of development that has been implemented, the results of a problem-based math learning device for algebraic materials and comparisons of Grade VII junior high lesson plan and Student Worksheet are valid, practical and effective.
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