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Validity of Guided Discovery Models-Based Learning Devices to Improve Mathematical Problem-Solving Ability

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***Abstract*—This study aims to produce a valid learning device based on guided discovery models to improve mathematical problem-solving ability. Learning tools developed in the form of Lesson Plan (RPP) and Students' Work Sheet (LKPD) of mathematics subject for the class VII of junior high school. The learning model is a guided discovery model that consists of formulating problems, analyzing data, preparing forecasts and providing training. The purpose of the guided discovery model is to engage learners actively in learning activities and bring them gaining more knowledge with their invention. This learning tool uses a Plomp development model consist of 3 phases, namely the preliminary research phase, development or prototyping phase and assessment phase. Learning devices are said to be valid if they meet the validity of content and constructs. The instrument used is a validation sheet containing aspects of presentation, content and material feasibility, graphics or display and language. Expert validation results show that the learning devices were valid.**

Keywords—Learning Device, Validity, Guided Discovery Model, Problem Solving Ability

I. INTRODUCTION

Mathematics is one of the sciences that has an important role in forming the mindset of students and is one of the things that cannot be avoided from learning, both formal learning and non-formal learning. So important is mathematics that learning mathematics can also help in solving problems in everyday life. Therefore, mathematics is one of the lessons taught at every level of education, starting from the basic education level to the highest level of education.

Problem-solving, one of the students skills, is needed to improve learning outcomes. The problem solving ability itself is not just a goal in mathematics learning, but also something that is very meaningful in everyday life, and in the world of work. Being a problem solver can provide benefits. It means the problem solving not only a math goal, but also something that is very important in daily life which have many benefits [1].

The importance of problem solving in schools is one of the learning objectives arranged in Ministry of Education and Culture Regulation No. 58 Tahun 2014 about curriculum 2013 SMP/MTs in which learners can (1) Understanding the concept of mathematics, is a skill in explaining the interconnection between concepts and the use of concepts and algorithms, in a flexible, precise, efficient and precise way; (2) Use the model as a conjecture in problem solving and able to make generalizations based on phenomena or existing data; (3) Use reasoning in nature, perform mathematical manipulations both in simplification and in the analysis of existing components in problem solving in the context of mathematics and mathematics outside; (4) Communicate ideas, reason and be able to construct mathematical proofs by using complete sentences, symbols, charts of charts or other media to clarify circumstances or problems; (5) Have an appreciation of the usefulness of mathematics in life; (6) Have attitudes and behaviors consistent with values in math and learning ; (7) Driving motor activities using mathematical knowledge ; and (8) Use simple accessories as well as technological results to perform mathematical activities.

Education currently uses curriculum 2013 which has the competence of graduates to be problem solvers. This was done to give students the skills of mathematical thinking as problem solving, mathematical reasoning, mathematical representations, and mathematical communication connections [1].

The skills that learners must achieve in learning mathematics as formulated in the *Permendiknas* and also *NCTM* as well is the problem-solving ability. Problem solving skills are the main result of a learning process. Learners should be able to solve real-world mathematical problems. This is seen for the purpose of learning mathematics, that is, learners are expected to solve various problems.

Problem solving can be seen from two different perspectives, namely as problem solving approaching learning and problem solving as learning objectives. Problem-solving as an approach means it is used to understand the material and find concepts from mathematics [2]. Problem-solving as a goal is intended so that students can formulate problems encountered in daily life and mathematics lessons, applying strategies to solve routine and non-routine problems, able to form mathematical models and be able to use mathematics meaningfully.

The improvement of the process of learning mathematics in the classroom must be accompanied by learning tools that can implement an effective and efficient learning process.

The learning tools are the Lesson Plan (RPP) and the Student Worksheet (LKPD) that can enhance the classroom learning process and improve the learning objectives. Therefore, teachers should provide learning tools before the learning process takes place.

An effort that can be made by teachers in the above problem is by providing Lesson Plan and worksheet to familiarize learners with solving mathematical problems and actively engage learners to be people who are able to solve the problem with the settlement of more effective strategies . In addition to providing learning tools, the teacher must also choose a learning model that can improve problem-solving skills. One of the learning models that is studied in this research is the guided discovery model.

Guided discovery model purposely designed to improve students activeness larger, process oriented, to find their own information required in achieving the learning goals. It means that Guided Discovery models are designed to improve learners, more process-oriented, to find their own information needed to achieve learning objectives[3].

It was concluded that the guided discovery model was a model to increase the activeness of students so that learning objectives were achieved. Guided discovery model is a learning model that conditions students to think for themselves, so they can find the desired concept with guidance and guidance from the teacher in the form of questions that direct [4].

Guidance on the guided discovery model is intended so that the findings made by students are more directed and provide guidance to students who have difficulty in finding mathematical principles and procedures and creating more efficient learning in terms of time.

Guided discovery learning models has an effect on the learning outcome of 28.32% and the scientific attitude of 25.90%, both being in a moderate category [5]. The results show that learners can be motivated and help learners understand the concepts found using guided discovery models [4]. Other research results showed that learners with guided discovery models produce better mathematics learning outcomes than learners with direct learning models [6].

Guided discovery is the teaching method that employs exploration, manipulation and experimentation to find out new ideas, and it is a problem solving strategy. It means that guided discovery is a teaching method that uses exploration, manipulation and experimentation to find new ideas, and it is an inexperienced strategy problem solving [7]. The guided discovery model is a way of delivering mathematical topics in such a way that in the learning process allows students to find their patterns or structures of mathematics through a series of past learning experiences and cannot be separated from teacher supervision and guidance.

In addition, guided discovery models are a teaching procedure that focuses on individual study, object manipulation and experimentation by learners before generalizing until learners are aware of 'a concept [8]. Thus, the guided discovery model of the learner makes its own discovery of mathematical principles and procedures, while the teacher guides them in the direction that will be approached correctly.

The steps that must be taken by the teacher to determine the guided discovery model as follows: (1) Formulate problems to provide learners with sufficient data; (2) Students organize, process, organize and analyze data; (3) Learners develop conjecture; (4) conjecture that were made by students examined by the teacher; (5) If she has obtained certainty about the truth of the conjecture, then the verbalization of it should also be directed to the learners to arrange it; and (6) Once learners have found what they are looking for, the teacher should provide additional questions or questions about the exercise to verify if the results are true [9].

The learning by the guided discovery will be maximal if teachers also design the use of students' worksheet. The worksheet is designed based on guided discovery models that can be used by students in solving mathematical problems. Students are encouraged to think, are asked to make an estimate of the problem presented, and students can draw conclusions from the problems presented. Through learning by using a guided discovery model, students are expected to be truly active in the learning process so that they are able to rediscover their own ideas and skills learned.

Problems given in worksheet do not not immediately give answers, students are given questions that can lead them to find the answers. Students answer these questions, and it is expected that students find their concepts from the lessons presented. Students are expected to be interested and challenged in learning and can improve students' mathematical problem-solving skills. The worksheet (LKPD) is also equipped with practice questions. Practice questions are made in the form of mathematical problem-solving skills in the form of descriptions.

The Student Worksheet (LKPD) based on a guided discovery model is expected to improve students'' mathematical problem-solving abilities. The guided discovery model is closely related to mathematical problem-solving ability is to compile, process, organize, and analyze a problem and provide a simple explanation, where the explanation will encourage students to issue ideas that aim to train students' abilities in improving mathematical problem-solving.

II. METHODS

This type of research was the development of research using Plomp models which consists of 3 phases, they are preliminary research, development phase or prototyping phase, and the evaluation phase [10]. This article discussed the prototyping stage that is about worksheet (LKPD) validation.

The preliminary study conducted needs analysis, curriculum analysis, analysis of concepts and analysis of learners. Data collection techniques were doing interviews with mathematics teachers, giving questionnaires and early tests to class VII students of SMP Negeri 2 Pariaman.

The prototying phase is realized by designing worksheet based on mathematical guided discovery models. The worksheet developed based on formative assessment. This evaluation consists of a self-evaluation, validation by an expert, an individual assessment, evaluation in small groups and field tests.

The LKPD that has been developed is validated by five experts who are called validators composed of three experts in mathematical education, an expert in educational technology and an expert in Indonesian language. The validators provided assessment and suggestions on the design of LKPD to determine weaknesses and benefits, and taking into account the expected product specifications using validation sheets.

The data analysis techniques used in this study were descriptive analysis. The data collection instruments were in the form of needs analysis sheet, curriculum, learners and concepts, observation sheet and interview guide. The validity analysis is performed on data obtained from the results of the validation instrument. Valid instrument includes self-assessment instruments and validation of instruments.

III. RESULTS AND DISCUSSION

In the preliminary study, needs analysis, curriculum analysis, concept analysis and analysis of students were carried out [11]. Needs analysis was carried out to get information about the problems found in SMP Negeri 2 Pariaman both faced by the teacher and students in the learning process. The information taken is related to the ongoing learning process, both from the aspects of the learning objectives set by the curriculum.

Getting information on the initial condition of students' mathematical problem-solving abilities is done by giving a test on mathematical problem-solving abilities based on the materials that has been studied. The mathematical problem-solving ability test was given to 32 students of class VII of SMP Negeri 2 Pariaman. While, the results of the students' answers sheet was examined by using the scoring rubric of mathematical problem-solving abilities as seen in Table I.

TABLE I. PERCENTAGE TEST OF MATHEMATICS LEARNERS PROBLEM SOLVING ABILITY

Indicators	Percentage of success				
	0	1	2	3	4
Understanding the problem includes: Identify known data, identify requested data, identify necessary data and verify data adequacy	35	16	13	35	3
Plan a settlement or choose a strategy	38	31	0	0	0
Apply a strategy or perform calculations to solve various problems	72	28	3	0	0
Explain or interpret the results according to the problem, including: re-examining the truth of the result or the initial problematic answers	75	25	0	0	0

Based on Table I, it can be seen that the percentage of students who achieved the highest score for each indicator is still low. This shows that the students' mathematical problem-solving abilities are still not optimal. It was concluded that students' mathematical problem-solving abilities were still low.

Based on the results of interviews with the teacher, information was obtained that the learning activities in the classroom using the 2013 curriculum were emphasizing on students about attitudes and behaviors while in class. However, many of the students did not heed it. When the teacher is explaining the lesson, there are still some students who are not focused on learning.

The initial investigation phase is carried out to obtain information about the abilities and characteristics of students, as well as the needs of students. This phase has several activities. Curriculum analysis was done to the 2013 Curriculum for Mathematics in Grade VII of Junior High School. This analysis is needed to study material coverage, learning objectives, selection of appropriate strategies as a basis for developing the expected learning devices and used in the guided discovery model.

Analysis of students aims to find out the quality of individuals who can be used as clues in designing learning devices. The focus of the activities carried out is how the characteristics of students include the level of thinking, learning tendencies, how students learn to use designed learning tools. In this study, students of class VII SMP 2 Pariaman became the subjects of the research.

Concept analysis is the identification of essential materials that will be discussed in learning and then compile them systematically by linking a concept with other relevant concepts to form a new one. Concept analysis aims to identify facts, concepts, principles, and to determine the content and subject matter that can be presented in LKPD based on guided discovery models. The content and subject matter are adapted to the existing components of the guided discovery model.

The prototype-making phase begins with designing LKPD based on guided discovery models. This design is called prototype 1. The design of this LKPD is based on the results of preliminary research that has been carried out.

The LKPD is generated based on the guided discovery model, the researcher then conducts self-evaluation for construct validity and content validity to discuss with experts. Validation of LKPD contents based on guided discovery models was carried out by five experts consisting of three Mathematics education experts, one language expert and one educational technology expert.

The validity of the content means the suitability of the product produced with several criteria that are determined, conformity with the applicable curriculum content, suitability of the learning device with the syllabus, and the suitability of the device with the learning objectives.

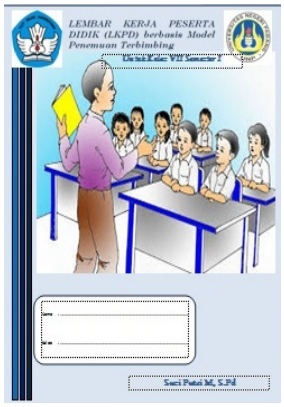
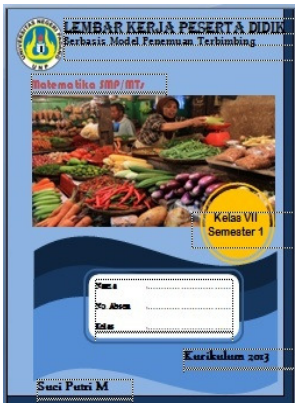
While construct validity means conformity between products produced with the elements of development that have been determined. Construct validity in LKPD based on guided discovery models is obtained through the preparation

of devices based on the characteristics of the subject that is the target or the expected behaviour of the subject.

Data from the validity results are obtained by providing a validation sheet to experts in mathematics education, educational technology and language experts. The aspects assessed in the LKPD are aspects of presentation, content and material feasibility, graphics or appearance and language.

In self-evaluation errors, the researchers found several errors in worksheet include typing errors and punctuation errors. After self-evaluation, guided discovery models-based worksheet are validated by the validators. Based on the findings of errors in self-evaluation and suggestions of validators, improvements were made to the worksheet based on the guided discovery model as follows.

TABLE II. VALIDATORS SELF-ASSESSMENT AND RECOMMENDATIONS

Before the review	After the revision
	

Based on Table II, validator give advice to modify the cover for makes the learners more interested in lessons process. After the improvements are made, the validators provide an assessment of worksheet. Overall, the worksheet based on guided discovery models that are validated by mathematical experts have fulfilled valid criteria with a validity index on presentation aspects of 0.78 and aspects of feasibility content of 0.78. This means that the characteristics and suitability of students' worksheet with guided discovery model-based can help students to improve mathematical problem-solving abilities.

The aspect that is seen next is the graphic aspect or appearance. The graphic aspect or display is validated by one lecturer in Education Technology. Analysis of the data of the graphic aspect validation results or the display obtained on average is 0.67 with a valid category.

Thus the graphic aspect or appearance is valid. The last aspect that is validated is the aspect of language. This language aspect is validated by one Indonesian lecturer. The analysis of validation data showed 0.92 validity index with valid criteria, this means that the language used in students' worksheet has been communicative and is valid. The overall validation results in each aspect can be seen in Table III.

TABLE III. RESULTS OF THE VALIDATION OF STUDENTS WORKSHEET BASED ON DISCOVERY LEARNING MODEL

No	Aspect of validation	Validity index	Category
1.	Presentation	0.78	Valid
2.	Didactics and content (material)	0.78	Valid
3.	Challenge (Display)	0.67	Valid
4.	Language	0.92	Valid
Average validity index		**0.78**	**Valid**

Based on Table III, it can be seen that the average LKPD validation as a whole is 0.78 with valid criteria. So it can be concluded LKPD and guided discovery-based to improve problem-solving skills have been valid and can be tested on class VII students in SMP Negeri 2 Pariaman.

IV. CONCLUSION

Based on the process and results of the study, it is concluded that the development and design of this product have resulted in students' worksheet of mathematics based on guided discovery models to improve the problem-solving ability of students in junior high schools which is considered in valid criteria.

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