

Mathematics Learning Tools Development Based on Guided Discovery Model to Improve Students' Problem Solving Ability

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Abstract—The purpose of this study was to create a valid, practical and effective learning tools based on guided discovery to improve the mathematical problem-solving ability of grade VII students of SMP / MTs. The developed learning tools are Learning Implementation Plans (RPP) and Student Worksheets (LKPD). This research is a development research using Plomp model which consists of three stages, namely preliminary research, development stage, and assessment stage. In the development stage, the design and assessment of learning devices is carried out through the stages of formative evaluation. The subjects of the field test involved in this study were the seventh-grade students of Islamic Junior High School 5 Lima Puluh Kota. The instruments used are lesson plan validation sheet, worksheet validation, teacher response questionnaire, student questionnaire responses. The instruments are firstly validated by mathematicians, linguists, and educational technology experts. The results of the analysis of the lesson plan and worksheet validation sheets show that the developed learning tools are valid. Learning tools are practical based on the results of the analysis of teacher response questionnaires, student questionnaire responses, and learning implementation observation sheets. In addition, the learning tools developed are also effective to improve students' mathematical problem-solving abilities based on the test results.

Keywords—learning tools development, mathematics, guided discovery models, and problem solving.

I. INTRODUCTION

Education is a process of transforming students by performing certain tasks as a result of the process they follow. Education is essentially an effort to provide certain knowledge, insight, skills and competencies to individuals so that they can develop to cope with any changes resulting from advances in science and technology.

The educational system in Indonesia generally remains focused on cognitive intelligence. In parallel with changing times, the goal of learning mathematics in Indonesia is also changing as requirements and needs change. The learning process is a complex set of events, in which there is a reciprocal relationship between students and teachers. According to Suherman [1], learning is an environmental structuring effort that gives a nuance to the optimal growth and development of learning programs. The purpose of learning mathematics according to Regulation No. 22 of 2016 of the Minister of National Education [2] is (1) Understanding of mathematical concepts, (2) Use reasoning

on models and traits, (3) Solve problems, (4) Communicate ideas and (5) respect the usefulness of mathematics in life.

According to the learning objectives of mathematics, the level of competence to be achieved in secondary education / SMP/ MTs / SMPLB / PAKET B according to Regulation 64 of 2013 of the Minister of National Education [3] includes the understanding and application of knowledge (factual, conceptual and procedural); and treatment, presentation and reasoning in the concrete and abstract fields.

According to the observations that be done at the Islamic Junior High School 5 Lima Puluh Kota in August 2017, the writer attempted to highlight of mathematical problem solving abilities of pupils in class VII. Students give a pretest of problem solving skills with an average of 33.3%. In other words, there are still many students who have not been completed and the percentage of completeness of students in problem solving is still lacking. This shows that the students' problem-solving ability, each represented by three mathematical problem-solving indicators, is still not optimal. In addition, learning materials that are suitable for all students are needed because of the variation of students' abilities, teachers are more inclined to use conventional learning methods because they are seen as more effective, and students understand more quickly how to use them. material taught. In addition, the teaching material used so far is only in the form of a summary of material and collection of questions.

Mathematics learning should help students discover their own guided subject concepts. To do this, the teacher can develop a learning activity to encourage students to use their mentality.

Based on the observations of how teachers way, get some information that the learning activities conducted by teachers refers to the effort of educating learners but the role of the teacher is still dominant so that students do not have enough space to build their own knowledge. In addition, learning activities also do not facilitate problem-solving skills. Students are not familiar with the form of questions related to problem-solving skills. Problem solving is not immediately reflected in the solution but requires a specific strategy to find a solution. Learners can determine what is known and asked of the question, but sometimes students difficult to understand the information related to the topic. As a result, the students are not able to identify or develop

appropriate resolution strategies to find solutions to these problems. It causes the learners to tend to be confident in solving any problem given by the teacher, because of that the teacher uses a model of guided discovery. Students are still reluctant to understand the problem and apply the concept to problem solving.

Increasing the ability of students' mathematical problem-solving skills and the teachers' role so far, the writer proposes the use of guided discovery-based learning models. Learning with guided discovery models is the right choice to improve math problem-solving skills. Learning based on a guided discovery model begins with the provision of problems that must be understood by students. After that, the students make observations in the group with the teacher's advice until a solution is finally found to the problems posed. So, guided discovery learning can improve students' mathematical problem-solving skills.

The application of guided discovery learning requires learning device based on features and guided discovery measures, one of them is a lesson plan. According to Trianto [4] lesson plan is a plan that outlines the procedures and organization of learning to acquire the basic skills specified in the standards of content and have been described in the program. The Components of the lesson plan is based on the Regulation of Ministry of Education and Culture Number 22 in 2016 [5] (1) the identity of the school/madrassah, topics or themes, class/semester, subject, time and the purpose of learning. (2) Basic skills, basic skills and indicators of achievement of skills. (3) Learning material. (4) Learning methods. (5) Learning activities including preliminary activities, core activities and closing activities. (6) Assessment, remedial learning and enrichment. (7) Media, tools, materials and educational resources. Lesson plan was developed because of a guide implementation of a learning process that will determine the actions of teachers and learners in achieving learning objectives, according to Kurniasih [6]. The use of approaches, strategies, models and learning models is also reflected in the lesson plan so that the development of the lesson plan is the right one in designing the desired learning process.

Proponents of the implementation of guided discovery based learning models, needed appropriate educational resources in the form of student reference books, modules, and worksheets. According to Rahayu [7], the learning resources used can actively involve students in learning. The researchers chose the development of the worksheet in this study because the preparation of the worksheet is very possible to guide the students towards their own mathematical concepts. Unlike the book or source module that presents more concepts in their final form.

The worksheet aims to help students in understanding the material and help the teacher in activating the learning activities so that the students are more motivated to try finding the problems in the worksheet and discuss with their friends. According to Susanto [8], the benefits of using the worksheet in learning mathematics are (1) activating students in the learning process. (2) Help students develop concepts (3) Develop and apply difficult subjects and deliver orally.

So, the researcher designed a mathematics learning device based on a guided discovery model supported by the

worksheet so that the result of learning can help students find concepts and improve their problem-solving skills.

Based on the observations obtained in the field, the mathematical learning device consisting of a lesson plan and worksheet is not optimal. This can be seen in the lesson plan used did not use a learning strategy appropriate with the needs of students. Based on the problems faced by the students, lack of understanding concept, one of the strategies that can be used by teachers are learning that can lead students to find the concept itself.

The worksheet used was not able to allow students to develop students' mathematical problem solving skills. The worksheet used in the schools has not seen any questions or statements requiring students to solve the problems, finally, the students' of mathematical skills to solve problems is lack. According to Syarifuddin [9] the worksheet gives an instruction that guides the students in solving mathematics problem step by step, such as: understanding the problem and build mathematics model.

In improving students' problem-solving skills and overcome the above problems, teachers need to do more innovative learning by developing a mathematics learning tool based on guided discovery models. Improving student learning outcomes requires an improvement in the learning process. Because of that, a study in developing a mathematics learning device based on a guided discovery model is needed. The device developed should help students improve the problem-solving skills of student learning outcomes. The teaching system using mathematical learning devices based on guided discovery models should be more effective, relevant and efficient. For this reason, research was conducted with the title "Development of learning devices for mathematics based on guided discovery models to improve the problem-solving ability of class VII students in Islamic Junior High School".

The formulation of the problem in this study is "How is the process and results of the development of learning models based on junior high school guided discovery models valid, practical, and effective in improving the students' mathematical problems solving skills?". The purpose of this study was to determine the process and results of the development of learning devices based on guided discovery models in class VII Islamic Junior High School that are valid, practical, and effective in improving students' mathematical problem-solving skills.

By learning using a guided discovery model, students need to be really active in learning in order to discover their own concepts and principles. The steps for the teacher to determine the guided discovery model according to Markaban [10] are: (a) formulating the problem that will be given to the students with sufficient data. (b) Using the data provided by the teacher, the students compile, process, organize and analyze the data. (c) Students prepare a conjecture based on the results of their analysis. (d) if needed, conjecture that made by the students must be check by the teacher. (e) If certainty about the truth of the conjecture has been gained, the verbalization of the conjecture must be directed to the students to arrange it. (f) After students have found what they are looking for, the teacher should provide practical questions or additional questions to check if the results are true.

Through these steps, it can be concluded that in the learning process using this guided discovery model, students encounter problems or information in the form of comprehensive data provided by the teacher. In addition, students process the data until they get a response forecast and follow with applying the answers they found by working on the practical questions prepared by the teacher.

Thus, through this model, students are free to investigate and draw conclusions. This model requires a relatively long time in its implementation, but the learning outcomes obtained are certainly proportional to the time spent.

Some previous researchers [11,12,13] have conducted research on guided discovery. The relevancy to existing research is to use the guided discovery model, but in this study, we examined the digital material to improve problem-solving ability by examining validity, practicality and effectiveness.

Some indicators of the ability to solve mathematics learning problems are consistent with Effendi reviews [14], (1) ability to understand problems, (2) ability to solve the problems, (3) ability to do action or accounting, (4) ability to recheck or perform back.

II. METHOD

This research is development research used to produce certain products and test validity, practicality and efficiency. The development model used in this study is an adaptation of the Plomp model developed by Tjeerd Plomp [15]. This development model starts from preliminary research, prototyping stage, and assessment stage. The preliminary research consists of a needs analysis, a curriculum analysis, a concept analysis. This phase is necessary to obtain information on the problems in the field of education (there are gaps between the existing situations and the expected situations). The purpose of this phase is to obtain information on existing problems and the possibility to improve and innovate in order to obtain the temporary characteristics of the product under development.

At the prototyping stage, the prototype was formally evaluated. Prototyping stage consists of a prototype 1, self-evaluation; prototype 2, the validation of the experts; prototype 3, an individual assessment; prototype 4, small group evaluation. At assessment stage, field trials were conducted in the class VII of Islamic Junior High School 5 Lima Puluh Kota, to verify their practicality and effectiveness. The data were collected using self-assessment sheets, validation sheets, observation sheets and guidelines, teacher and student response sheets, observation sheets, and The validation of the device was carried out by three mathematics teachers, an Indonesian lecturer and a lecturer in educational technology.

III. RESULT AND DISCUSSION

1. The result of Preliminary Research

Preliminary results are performed in order to know the shape and characteristics of the learning device to be developed. This step is carried out by analyzing the objectives within the limits of the subject to develop. In this phase, several activities were conducted, including needs analysis, curriculum analysis, concept analysis and student analysis.

Preliminary research is done by questioning and observing mathematics learning. Based on the results of the interviews and observations, the students need new learning models besides conventional learning commonly used in the schools that are better able to optimize skills in solving students' mathematical problems. In addition, the existing lesson plan and worksheet must be refined to meet the requirements of the 2013 program, so that the lesson plan and worksheet can help teachers and students achieve optimal learning and learning outcomes. In addition, the worksheet must also be equipped with student problems and activities to solve these problems, in order to help them understand the material being studied. The worksheet should also contain questions of practice in the form of questions so that students can practice developing their mathematical problem solving skills.

Based on the curriculum analysis, in the first semester there are four subjects: bilangan, Himpunan, algebra and variable linear equations. The material taken for the development of the device in this study is the number of material.

At the analysis concept, doing identification activity, detailing and arrange the main materials systematically that will be learned by the students. As a result of the concept analysis, digital material is taken as a learning tool for developed math. The main concepts of the first half of the number of materials are all (positive and negative) and the fractions (common, mixed, decimal, percent), arithmetic operations involving integers and fractions, total numbers, KPK and FPB.

Based on students' analysis, it can be concluded that students did not actively participate in learning. Many students did not follow the learning to the fullest, this is indicated by the number of students who perform activities other than learning activities. Another information obtained is that the students did not use the worksheet. Students want an attractive and colorful worksheet.

2. Prototyping Phase

The purpose of this development is to produce mathematics learning tools for class VII junior high school, based on guided discovery models, to improve the students' problem solving ability, accuracy, practical and effective. After learning indicator is formulated and the main concepts are determined by the needs analysis, curriculum analysis, conceptual analysis and preliminary student analysis at the first stage so that the tools learning can be designed.

a. Designing learning devices

Design mathematical learning devices based on guided discovery models based on an analysis in the first investigation. The results of this design will produce a prototype 1. The designed learning device refers to the characteristics of learning models based on guided discovery. The following is a description of learning tools based on PBL learning.

1) Characteristic of Lesson Plan

Lesson plan arranged based on Basic Competition, consisting of several indicators. Lesson Plan is designed as a guide for the teacher to deliver the teaching materials. The learning activities presented in the lesson plan related to learning based on guided discovery models integrated into worksheet based on guided discovery models. The learning has been divided into three activities, such as preliminary

activities, main activities, and closing activities. According to Kunandar [16], the implementation phase of learning activities of the curriculum in 2013.

In the introductory activity, learning begins by providing motivation and focusing students' attention on active participation in the learning process. The method used by the teacher is orientation, apperception, motivation and reference.

The next activity performed in the learning process is the main activity. The main activity is a learning process to achieve the learning objectives. At the main activity, the teacher introduces the guided discovery model first, then the students are confronted with several problems related to the material studied. Then, from this problem, the students discuss with their friends.

Then, the teacher asks the students to talk in groups. Students discuss all the information in the problem by correctly writing the known information from verbal statements and writing questions that represent problems in order to fully understand the problem. Next, the teacher asks one group to present the results of the group discussion in front of the class and the other group responds to the presentation group's explanation. After a group discussion, students are invited to work on the exercise questions to see students' understanding of the material learned.

The last activity is closing activity. At the closing activity, students summarize the material taught with the teacher's advice, and the teacher informs the material to be learned at the next meeting.

2) Characteristics of Students Worksheets

The characteristics of Students Worksheets are divided into several aspects, Such as:

a) Content aspect

The presentation of the material begins by giving problems in daily activity related to the material being studied. Students are asked to solve problems given based on their knowledge and questions that must be answered by students so that students can solve the problem given.

Students Worksheets contains questions that encourage students to solve problems. Students can answer in the space provided. In answering questions, students can discuss in their group so the students can combine their ideas to answer questions. This can involve students in solving these problems actively. Students must understand the problem first.

In the next section, students receive practical questions about the level of understanding of the concepts they are learning. Through practice, students must gain a learning experience and understand the material being studied. Students who have found their own understanding and who have been highlighted by the teacher are tested for their understanding through these practical Students Worksheets questions based on guided discovery. Through this exercise, hopefully, that students can increase their understanding of the concepts or principles learned and prove that they know and understand with the material. The number of questions for each material varies.

b) Language aspect

Students Worksheets uses a standard language consistent with Indonesian spelling (EBI). Students Worksheets uses a simple and communicative language and is consistent with the level of understanding of junior high

school students so that the presentation of the material on the Students worksheets can be understood by the students well. The worksheets questions are organized in clear sentences so that students can be guided towards the expected answers.

c) Presentation aspect

This aspect focuses on the design of the cover, the type of font used, the layout, the adequacy of the text and the size of the image, as well as the parts requiring highlighting. The cover page/cover contains the identity or title of the worksheets based on the guided discovery, the subject treated, the identity column of the student as the owner of the worksheets. Worksheets are designed in the blue color because of blue gives a natural and fresh impression.

Based on questionnaires about the characteristics of worksheets that students want, the main background color used in the worksheets based on guided discovery models is blue. The blue color also has a lot of positive influence on the psychology of the reader.

b. Self Evaluation

The completed lesson plan, then reviewed by the researcher using a self-assessment form. Generally, many errors occur when entering words and punctuation. Punctuation errors, for example, after punctuation is not spaced apart by 1 space, lack of punctuation marks such as dots and commas, letters are not capitalized after a dots. In addition, there is also a cut chart with the next page so that the title is not visible. In worksheets typing errors, letter defects, an accuracy of text size, less punctuation.

After the self-evaluation, a review of the learning device was performed. The results of this revision are called prototypes 2. The results of a prototype I am then consulted or discussed with competent and validated experts.

The results of the validation lesson plan show that the value of each aspect is very valuable. The overall lesson plan developed is said to be very valuable with 92.99%. It can be concluded that the lesson plan based on the guided discovery model is very valuable. In the results of the validation worksheets, we see that for the content, the average validity is 92.1% with very valid categories, 100% of the linguistic aspects with very valid categories and 75% of graphic aspects with valid categories. In general, the validity of worksheets is 88.57% with a valid category.

c. Individual evaluation results

At this stage, the developed worksheets were tested to 3 students of class VII of Islamic Junior High School 5 Lima Puluh Kota with high, medium and low abilities. This worksheet based on guided discovery is given to students to fill in according to their abilities, after that the students are invited to comment on the given worksheets. The worksheets are given to the students outside of learning hours on different days. This evaluation was conducted at 9 worksheets.

The worksheets are given to students, the researchers are pay attention to what students are doing and record the obstacles while working on the observation sheet. The questions asked are more dominated by students with moderate abilities and weak abilities. Based on student questions, researchers provide guidance that guides students to develop their knowledge. With the given direction,

students can easily understand and do activities on the worksheets correctly.

With respect to the details of the individual assessment, revisions are generally limited to the improvement of the sentence. Improvements have been made to obtain a learning device based on better guided discovery. The results of the individual assessment improvements are called prototypes 3.

d. Small group evaluation results

In the small group evaluation, The worksheets based on the guided discovery that was the subject of individual assessments and was reviewed and then tested on small groups consist of 6 students class VII of Islamic Junior High School 5 Lima Pulu Kota that have high, medium and low abilities.

Based on the observations, there are several revisions of the learning device, especially in terms of time, the students need a lot of time to perform the exercises contained in the worksheets based on problem-solving approaches.

e. Field Test

The results of the reviews at each individual and small group assessment meeting were followed by a field test in the class VII.2 Islamic Junior High School 5 Lima Pulu Kota. This test was conducted to see the practicality and effectiveness of learning tools designed.

3. Implementation assessment of lesson plan

a. Practicality test

The purpose of practicality test worksheets of guided discovery is to determine the extent to which the benefits, ease of use, and effectiveness of using discovery-based worksheets are guided by the teacher and students. In examining the practical worksheets aspect of the guided discovery, the test was conducted nine times, in the digital material. Practical data are obtained from observations of the implementation of learning and the results of practical questionnaires by teachers and students. The results of the worksheets feature based on guided discovery are described as follows.

b. Questionnaire of teacher and student responses

Based on the results of the teacher response questionnaire, it was found that the average practical worksheets results based on guided discovery models ranged from 84.72% to 90.73% with very practical criteria. With practical criteria to be very practical, while the results of the student response questionnaire show that the results of the average practicability test for worksheets are based on guided discovery models of 87.5% to 100% with very high criteria. It can be concluded that teachers and students perceive the worksheets on the basis of guided discovery models as being very practical for mathematics learning in class VII of Junior High School.

In evaluating the practicality of this device, the data are collected by observing the implementation of learning, a practical questionnaire completed by students and teachers. Implementing learning using guided discovery model learning tools shows that the learning process can create a good classroom situation that encourages students to ask questions, answer questions, and express opinions and interact. In addition, learning with devices based on problem-solving approaches can very well stimulate

students to improve student motivation and enable them to develop their independence and creativity to understand the worksheets and solve problems.

Based on the above explanation, the lesson plan and worksheets based on the guided discovery model were practical for class VII students of Junior High School. In the learning process, the teacher does not encounter significant difficulties in using the Lesson Plan. The worksheets used by students can help them understand a concept of the subject. In terms of time, lesson plan and worksheets are used extensively to complement learning activities.

c. The ability of student problem solving test

The effectiveness of mathematics learning devices can be seen from the results of mathematical problem solving skills tests. It can be said that the learning device based on a guided discovery model is effective if it is able to increase students' mathematical problem solving skills.

The learning outcomes obtained in this study come from tests given in the form of a description test of up to three elements. This test is done to assess the cognitive abilities of students after learning using the worksheets based on Guided Discovery. This test is given to class VII₂ students with 27 students. The results of the problem-solving tests are of 24 students, or 88.89%, which means that the students have a score above the specified minimum completeness criteria score and 3 students or 11.11%, which means that the student value is always lower than minimum completeness criteria. In addition, from the class average, learning using guided discovery-based learning tools is 82.92, which means that, conventionally, it is complete. According to the results of this final test, more than 75% of the students are above the minimum completeness criteria.

IV. CONCLUSIONS

This research is a development research that produces a learning tool based on a guided discovery model. The device is in the form of a lesson plan and worksheets of Class VII on number material. From the development results, we can conclude the following points (1) The form of a mathematical learning device based on valid guided discovery is a learning tool based on a guided discovery. (2) The practical form of mathematical learning devices based on guided discovery is a learning tool that helps the teacher to implement the steps of lesson plan activities according to the time allotted. For students, the worksheets can increase motivation and build one's own knowledge through the stages of worksheets activities. (3) The form of discovery-based effective mathematics learning devices is a device that, in this case, is the lesson plan and worksheets, can direct students to various positive activities and minimize negative activities. In addition, learning outcomes after using this learning tool met the minimum criteria for completeness. It can be concluded that the production of a process and the results of a mathematics learning device based on a guided discovery model improves the problem-solving skills of Grade VII junior high school students. which are valid, practical and effective.

The researcher may suggest several things based on the conclusions and limitations of this study, such as: (a) lesson plan based on the guided discovery model for number material at the class VII of Islamic Junior High School in the first semester are valid, practical, and effective so that

can be used by mathematics teacher as an alternative in learning. (b) For other researchers who will continue this research, it is advisable to innovate in further research such as the development of mathematical learning tools for other materials or new innovations in mathematical learning devices.

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