ISSN 2964-4291
https://proceeding.unnes.ac.id/index.php/iset

Developing Discovery Learning Worksheet to Foster Junior High School Students' Mathematical Literacy

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Abstract. This study aims to develop student worksheet for junior high school students in the setting of discovery learning and find out its validity and practicality. The developed worksheet is expected to be valid and practical to foster the students' mathematical literacy. We used the framework of analysis, design, development, implementation, and evaluation (ADDIE) to develop the worksheet. During the development, we involved experts in school mathematics to review the content, experts in learning media to review the worksheet quality as a form of media, and 34 eight grade junior high school students in Yogyakarta to try out the worksheet. The material used in the worksheet is circle. During the validation process, we used the check list instrument, while in the try out process, we used questionnaire. This study successfully produced a valid and practical worksheet to foster the students' mathematical literacy. Experts provide score of 151.5 (very good) in substantial aspect and score of 149 (very good) in media quality aspect. Moreover, the average score of students' response towards the developed worksheet is 125.6 (good), which indicates that the worksheet is practical.

Key words: circle, discovery learning, mathematical literacy, student worksheet

How to Cite: Istihapsari, V., Sukestiyarno, Y. L., Suyitno, H., & Rochmad. (2022). Developing Discovery Learning Worksheet to Foster Junior High School Students' Mathematical Literacy. *ISET: International Conference on Science, Education and Technology* (2022), 321-327.

INTRODUCTION

Education is important for human life. Through education, humans can gain insight and knowledge to support their lives. Education today along with the times has reached the rapid development of technology. Various media and teaching materials have been used to support the educational process. Currently, the 2013 curriculum is the curriculum used in Indonesia which requires students to play an active role in learning, while the teacher's role is as a facilitator in learning.

Mathematics is a compulsory subject in the 2013 Curriculum which is considered important in supporting success in education. However, according to OECD (2019) based on the results of the 2018 Program for International Student Assessment (PISA) survey released on December 3, 2019, it shows that in the field of mathematics, Indonesia with an average score of 379 is ranked 7th from the bottom, or more precisely, ranked 73rd. Based on this, the ability of students in Indonesia in the field of mathematics is very lacking, which can be seen based on the 2015 PISA report with an average score of 386. It indicates the low level of mathematical literacy among the Indonesian students.

Geometry is one of the materials in mathematics that must also be mastered by junior high school students. One of the geometry materials for eight grade students is circle material. The circle material from elements to other parts is very close and even useful in everyday life. But in reality, students have not fully utilized the concept. This is found in Melinda et al (2017) who stated that students often have difficulty in solving problems of circumference and area of a circle. It is because students also do not understand the use of concepts. Students will be able to understand the material better if they can learn by finding their own knowledge. Therefore, there is a need for teaching materials. Student worksheets as teaching materials are in the form of sheets containing material, summaries and instructions that allow students to carry out activities on issues that lead to learning the basic competencies to be achieved (Prastowo, 2011). In the 2013 curriculum, the government provides textbooks for students to use in learning. However, in reality, textbooks are not optimal in guiding students in their learning. Worksheet can be developed to build independence and guide the mindset of students. It is hoped that with this worksheet, students can learn independently, actively and can understand the material well so that they can find their own knowledge.

Based on interviews with eighth grade mathematics teachers at a junior high school in Yogyakarta, it is known that the teaching materials that have been used in learning are summaries of material presented in powerpoint form, mathematics textbooks published by the Ministry of Education and Culture. In fact, teachers rarely use worksheet, teachers only provide material and examples of questions then students are given questions as assignments. So, worksheet that is more specific and contains elements such as learning models and learning methods based on the 2013 curriculum is not yet available. The teacher explains that students are still lacking in understanding the concepts and subject matter in the circle material, so that the participants in working on the questions on the circle material still find it difficult.

The results of interviews with several eight grade students who have taken the circle material show that in solving the questions on the circle material some students still find it difficult. This is supported by Bernard et al (2018) who states that, when students are trained to solve a problem related to the area and circumference of a circle, for example when given a problem how to find out the area of a wooden plank needed to cover a well. However, students still find it difficult to solve circle problems. It is in line with what Adilla et al (2020) said that students have difficulty in learning geometry, namely the circle material. Lestari et al. (2016) argues that one of the errors that are often experienced by students when solving problems of area and circumference of a circle is an error in applying the circle formula (concept error).

Discovery learning is a learning model that requires teachers to be more creative in making learning conditions more active, so that students can independently find their own knowledge (Sani, 2017). The reason the discovery learning model is used in learning at school is because it has advantages for the students. According to Markaban (2008), the advantages of discovery learning are: (1) students are more capable in problem solving; (2) students really understand learning, because students experience the process of finding it themselves; (3) discovering on their own can lead to a sense of satisfaction in students who encourage them to make more discoveries; and (4) students get many opportunities to learn on their own.

Furthermore, by engaging directly to the material, students could also exercise some more skills, for example, the mathematical literacy. Mathematical literacy is the ability of the students to formulate, to employ, and to interpret mathematics using various contexts (OECD, 2019). In this study, we used the 2018 definition and framework of mathematical literacy since it is the ones which have been implemented so far in the Programme for International Students Assessment (PISA), while the new definition and framework of mathematical literacy is still in the implementation in 2022 and we have not seen its results. There are seven capacities related to mathematics literacy which need to be fostered through innovative learning, namely communicating, mathematizing, representation, reasoning and argument, devising strategies for problem-solving, using symbol and formal language, and using mathematics tools.

The capacities could be fostered if the learning is designed to facilitate the students achieving them. Not only the learning model used, but also its equipments including the students' worksheet. Students' worksheet is one of learning instruments which helps teacher and students to achieve the learning objectives. Students' worksheet provides a clear procedure for students to work in particular sequence, and also helps the teacher to follow the designed sequence of instruction they have prepared. Therefore, its existence is fundamental as a learning tool.

In this study, we aim to develop the students worksheet which could facilitate the students to foster their mathematical literacy through a discovery learning. The learning was applied for circle material as it is one of the materials that junior high school students need to master in year eight. Second, we also aim to find out the validity and the practicality of the worksheet.

METHODS

This research is a research and development using ADDIE development model. The ADDIE model consists of five steps, namely analyzing, designing, developing, implementing, and evaluating (Sugiyono, 2011; Sutarti, 2017).

First, in the analysis stage, we analyzed the needs of teaching materials, curriculum, as well as the students need during the learning to achieve the learning objectives, namely to foster mathematical literacy. After the analysis process is complete, we use the results to thnk about the design of the relevant teaching material product. In this stage, we use documentation method to see the existing teaching material and curriculum demand. Moreover, we also interview to the teachers and students to find out the difficulty to

learn mathematics and support that the teacher and students need during the learning.

Second, in the design stage, we figured what the teaching material look like based on the results of need analysis. We have decided to develop a students worksheet. Therefore, we detailed the characteristics need to be developed in the worksheet, such as the learning model used during the learning, the characteristics of the worksheet which related to mathematical literacy and so on. We also developed the criteria, such as relevancy to the existing curriculum, using language that is easy to understand, and guiding students to learn. At this stage, an assessment instrument for the developed product is also carried out by making a questionnaire based on the grid created which will then be validated by material experts and media experts as well as making a student response questionnaire to the worksheet product.

Third, in the development stage, we produced the worksheet based on the the design we made. The product is created using Microsoft Word. After the product is made, validation is carried out by experts, namely validation by content experts (mathematics education lecturer and mathematics teacher) and media experts (mathematics education lecturer and mathematics teacher). The evaluation results also used to revise the products. The target of this stage is to find out the product validity before it is used for the next stage. In this stage, we used check list instrument to collect the experts' opinion to the product and their recommendation for revision.

The content expert validated the worksheet product using the criteria presented in Table 1 (36 items).

Table 1. Criteria of content validation

Aspects	Indicators
Content appropriateness	The relevancy of material to the basic competences.
	No misconception found.
	Up to date material.
Language appropriateness	Clear statement.
	Coomunicative.
	The relevancy of material to the students' cognitive development.
	The relevancy of material to the language principles.
	The appropriate use of terms, symbols, and icon.
Presentation apropriateness	Presentation technique.
	Presentation support.
	Learning presentation.
	Systematical thinking process.

Meanwhile, the media expert used the criteria in Table 2 to validated the worksheet product (31 items).

Table 2. Criteria of media validation

Aspects	Indicators
Graphical appropriateness	The relevancy of illustration to the material presented.
	The quality/resolution of illustration.
Layout appropriateness	Proportionally layouted.
	No blank space.
	Important material highlighted well.
Typographic apropriateness	The use of appropriate font style.
	The selection of font size.
	No mistyping found.
	Font consistency.

After the development stage is complete, then the forth stage is implementation. At the implementation stage, we applied the worksheet in the eight grade students learning. We tried to look at its practicality for usage at school. In this stage we used questionnaire to collect the students' responses regarding the use of the worksheet. We involved 34 eight grade students of junior high school in Yogyakarta to take part of the implementation stage.

The next stage is evaluation. The stage is actually carried out at the end of each activity or revision of each to be used as a reference for the revision of each stage as well as overall feedback from what has been made. Evaluation can be interpreted as giving value to the process of activities that have been carried out, namely through the results of questionnaires from material experts, media experts and student response questionnaires. In this product trial, several stages were carried out, namely expert trials, namely material expert trials, media experts and field trials. The subjects in this study were mathematics teachers and students of class VIII C. The data collection instruments used in this study were interview guidelines and questionnaires for validation of material experts and media experts as well as student response questionnaires.

The criteria of the questionnaire consists of two aspects, namely if the students could understand the assignment, could follow the activities in the worksheet, and could enjoy the learning (15 items). The collected data were presented using descriptive qualitative approach. We used Likert scale 1 to 5 in the questionnaire responses and categorized the response into five criteria, namely very good, good, fair, poor, and bad. The worksheet product is regarded as valid and practical if all aspects got responses at minimum of good level (Widoyoko, 2016).

RESULTS AND DISCUSSION

Analysis Stage

The first stage is analysis. In this analysis stage, researchers analyze several things to provide an overview of teaching materials that will be developed by researchers. The analysis process is very important in terms of development, because the results of the analysis are a reference in making teaching materials, namely as follows.

Analysis of teaching material needs, obtained from interviews with mathematics teachers and class VIII students to find out what teaching materials have been used during the learning process in class and what teaching materials are needed by students. In the analysis we found several facts. Students are good with any learning sequence (or learning model) as long as the teacher provide a clear guide to follow the learning steps. It was not enough for the teacher to explain the nature of a learning model they use prior to the learning, but a written procedure is needed. We saw that a worksheet is perfect with this need. Worksheet does not only consist of material exercise, but could be developed following particular learning procedure. The chacateristics of worksheet is appropriate to reach the learning objectives.

Analysis of the material was conducted by interview with the mathematics teacher of class VIII at Yogyakarta, and the results showed that the ability of students in understanding concepts and subject matter was still lacking in the circle material. The students found it difficult to work on the circle problems. Therefore, we chose the circle material as the material to be developed in the worksheet.

Curriculum analysis is carried out by conducting a literature study which includes an analysis of core competencies, basic competencies and indicators of competency achievement by students. In this analysis, we figured out the learning objectives in the circle material which the students need to achieve. Moreover, we also figured out the mathematics literacy feature that the students need to foster during the designed learning, such as integrating the three processes of mathematics literacy (fomulate, employ, and interpret) in the structure of the worksheet along with the learning sequence of discovery learning. Discovery learning is chosen because its characteristics work best with the need to foster the students mathematics literacy. It has syntax of stimulation, problem identification, data collection, data analysis, verification, and conclusion (Putri et al, 2020).

Design Stage

In the design stage, first, we collected material sources for the development of the worksheet. Then, we defined the elements needed to be put in the worksheet, such as the front dan back cover, the identity, table of content, concept map, various core activities, insight to important notes, conclusion, and exercises. We also develop the instruments of content validation, media validation, and students' questionnaire to evaluate the worksheet product based on the set criteria.

Development Stage

In the development stage, first, we construct the worksheet product using Microsoft Office Word 2010 based on the component and criteria set in the design stage. Then, we sent the worksheet for validation to the content experts and media experts. The experts provided feedback on the quality of the worksheet, as well

the criticism. Therefore, we followed it up by doing revisions. The sample of product appearance could be seen in Figure 1.

Figure 1. Stimulation phase of discovery learning which consists of formulation activities in mathematical literacy.

Figure 1 is part of the first activity in the worksheet which aims to recognize and find the concepts of circle elements. It starts with the context of Stonehenge, a site in England, which construct part of circle. Students are asked to formulate the model of Stonehenge and find out the elements of circle in it. It is the first phase of discovery learning and also the first step of mathematics literacy (formulation). Then, the students moved to the stage 2 of discovery learning, which are problem identification and stage 3 collecting data.

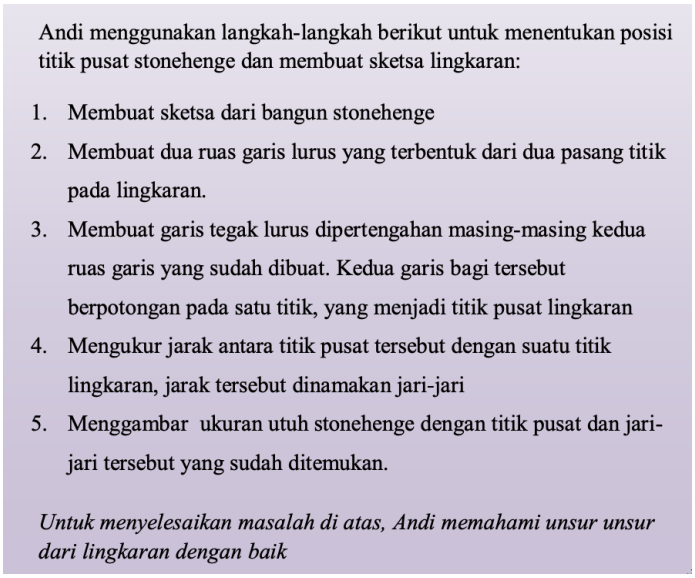

Figure 2. Procedures of finding the elements of circle.

The students could follow the procedures in Figure 2. Therefore, students could avoid misconception happens in mathematics.

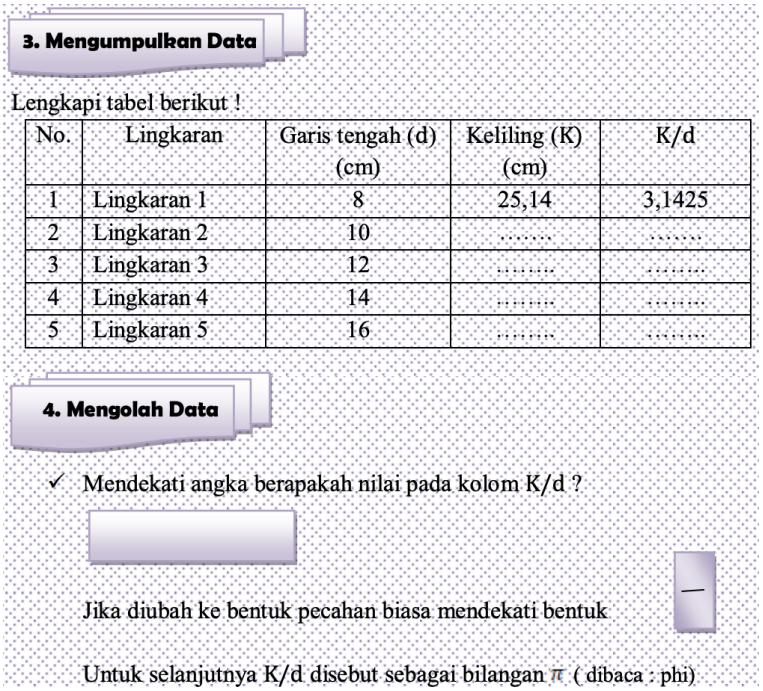

Figure 3. Activities of finding phi

In Figure 3, wee see that the worksheet guides the students to find the value of phi (approximation). In discovery learning, it belongs to the stages of collecting data and analyzing it. It is also categorized as the employing activities in terms of mathematics literacy. Moreover, the students would show various capacities in mathematics literacy, such as using tools in measuring the circumference of the objects, as well as their diameter. It also shows the capacity of representation in presenting the ratio, and communication in the presentation of table. The worksheet, therefore, provides habituation for students to employ the mathematics procedures as well as exercising various mathematics literacy capacities.

Furthermore, the feedback from experts are presented in Table 3.

Table 3. Experts' feedback

Validator	Score	Criteria
Content expert 1	141	Very good
Content expert 2	162	Very good
Media expert 1	140	Good
Media expert 2	158	Very good

Table 3 shows the quality of the worksheet based on experts' feedback. It shows that the worksheet is valid.

Implementation Stage

In the implementation stage, we conducted two times of try out. First, involving small group of 5 students of year 8 using Google Classroom with the setting of discovery learning. Second, we involved a large number of students consisting of 34 students using Google Classroom. The students' responses towards the questionnaire is presented in Table 4.

Table 4. Students' responses

Source (group)	Number of students	Score	Criteria
Big class	34	63	Good
Small group	5	62.6	Good

Evaluation Stage

Evaluation stage is conducted throughout the stages. We followed up every feedback we got either from experts, students, as well teachers to revise the worksheet such that we got a final product.

CONCLUSION

In this study, we successfully developed a worksheet for junior high school students to be used in learning circle using discovery learning model. The worksheet is also potential to foster the students' mathematical literacy as it consist of every feature of mathematical literacy processess, such as formulate, employ, and interpret, and also the seven capacities of mathematics literacy such as communicating, mathematizing, representation, reasoning and argument, devising strategies for problem-solving, using symbl and formal language, and using mathematics tools. The feedback from content experts suggested that the worksheet could be categorized very good, and the media experts also suggest the same category. Thus, the product is valid. Moreover, the students responses while using the worksheet suggest that the practicality is good. Thus, it is practical.

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