The Development of Guided Discovery-Based Student Worksheet to Develop the Spatial Intelligence on Geometry

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ABSTRACT
This study aims to develop a valid, practical, and effective guided discovery-based student worksheet which expected to enhance spatial intelligence. The topic is Plane Figure. The type of study was research & development of the ADDIE model, with 5 stages: analysis, design, development, implementation, and evaluation. The test subjects 8th D-grade students at One of the junior high schools in Sungguminasa, Gowa, South Sulawesi, Indonesia. Instruments consisted of a worksheet, observation sheet, student and teacher response questionnaires, student and teacher activity observations, and students' mathematical learning outcome tests. The results of the study show that: 1) the results of validation stated that the average scores of all components in student worksheet is 3.1, which is an invalid category; 2) the average scores of observation of student worksheet implementation are 1.24 with partially implemented category, the percentage of student response questionnaires is 71.8% with positive category, and the teacher response questionnaires are 83.9% with a positive category so that it is categorized as practical; (3) the average percentage of student activities for the whole learning meeting is 64.8% as good category, the student activities in managing learning are 3.78 as good category, and the mathematical learning outcome test obtained is 71.4 categorized as effective. Thus, it can be concluded that a guided discovery-based student worksheet help to overcome problems faced by the teacher on geometry since they met the validity, practicality, and effectiveness criteria.

Keywords: *Students' Worksheet, Guided Discovery, Spatial Intelligence**, **Solid Figure Material.*

1. INTRODUCTION

Education becomes a means to develop skills in solving problems. The development of educational sciences and technology has become one of the important factors in improving quality and competent human resources [1].

Mathematics has become one of the studies that support the development of sciences and technology. However, until this time, many students feel that mathematics is a difficult subject. This is because many students still have difficulties in doing mathematics problems [2].

The learning achievement of students in the school is often indicated by students' learning problems in understanding materials. This occurs because of less effective and motivated learning factors of students. The tendency of this learning is a natural thing experienced by the teacher who does not understand the needs of students. The role of a teacher as a knowledge developer is very great to choose and implement appropriate and efficient learning for students [3]. The teacher solves the problems by implementing improvement in the learning process. One of the determinants for the success of the learning process and the achievement of mathematics learning objectives is learning media.

Learning media is a set of instruments or components used in the learning process, consisting of the syllabus, lesson plan, teaching materials, and learning outcome tests. One of the printed teaching materials used in the learning process in the school is the student worksheet. A student worksheet is a guide

for students to develop cognitive aspects and a guide for learning aspects [4]. The learning will be more effective by using teaching materials used as a means of delivering information according to the subject's characteristics.

One of the learning alternatives that can be implemented by the teacher so that students can have an active and independent role in developing their knowledge is by using a student worksheet, which presents materials briefly and systematically so that students can easily construct information delivered[5].

Meanwhile, based on the results of observation in the school that was carried out by the researcher when learning activities in 1 Sungguminasa Junior High School in mathematics subject, During the learning process, after giving materials, the teacher also immediately gives questions in the textbook to be solved by the students. However, the students are still unable to solve problems in the textbook because the questions in the textbook have not supported students in developing their competencies. This makes students are not used to solving problems in their own way and not accustomed to constructing concepts in mathematics.

The facts above are related to an interview conducted with Mr. Saleh, a mathematics teacher for 8th grade, which stated that the teaching material used is mathematics book curriculum 13 revision 2017 distributed from school for the students. Teaching materials used already contain a definition, brief description of material concepts, and exercises. However, the language used in the textbook sometimes makes the students difficult to understand the materials. Therefore, in understanding the concepts, students are only focused on what is written in the textbook. This makes students still difficult in solving different problems with examples.

Therefore, developing a student worksheet that can help the teacher to facilitate students is required. The development of a student worksheet carried out must be in accordance with appropriate learning methods. The learning method chosen by the researcher is the guided discovery method, which makes students able to find concepts learned so that the materials can stand in the minds of students and the role of the teacher in guiding students in solving a problem.

The guided discovery method is a learning method that provides opportunities for students to compile, process, organize data provided by the teacher. Through the guided discovery process, students are required to use ideas and understanding that have been owned to find a new thing. In the process of finding a concept, the teacher can help to provide solution instructions, which directs students to be able to construct concepts [6]. The ability of understanding owned by students is different. There is one kind of intelligence required to understand the space around us.

Intelligence is spatial intelligence, which is centered on the ability of someone to capture the world of surrounding space, which is then redeveloped again in the form of imagination and thinking power [7]. Spatial ability has an important role in completing tasks in daily life.

To improve more effective learning process with the students who are directly involved or active in the learning process so that the learning process is more meaningful for students, one of the alternative teaching materials that can be developed to the mindset of students and the independence of students is by developing the guided discovery-based student worksheet to develop spatial intelligence.

2. RESEARCH METHOD

The type of this study was Research and Development. Research and Development is a research method used to produce certain products and examine the product's practicality. The product made and examined its practicality in this study is a guided discovery-based student worksheet developing spatial intelligence. This study used a development method that refers to the ADDIE developed by Dick and Carry with the abbreviation of Analysis, Design, Development or Production, Implementation, and Evaluation [8].

The place and test subjects of the study were 35 8th-grade students in Sungguminasa Junior High School of Gowa Regency.

The data collection techniques used were validation sheets, observations, questionnaires, and tests. The study instruments were validation sheet, observation sheet, implementation observation sheet, student response questionnaires, teacher response questionnaires, student activity observation sheets, learning management observation sheet using a student worksheet, and learning outcome tests. This study used three data analyses: validity analysis, practicality analysis, and effectiveness analysis.

3. RESULTS AND DISCUSSION

The development process of the guided discovery-based student worksheet was used to develop geometry for 8th-grade students in Sungguminasa Junior High School of Gowa Regency. The development of the guided discovery-based

student worksheet was used using the ADDIE model, and the following is a brief discussion:

a. Analysis Stage

Before developing a student worksheet, the analysis of the needs of students was carried out first, which is the low mathematics learning outcomes caused by a student worksheet used already contain a definition, brief description of material concepts, and exercises. However, the language used in the textbook sometimes makes the students difficult to understand the materials. Therefore, in understanding the concepts, students are only focused on what is written in the textbook. This makes students still difficult in solving different problems with examples. Responding to the problems, the researcher conducted a study on developing the guided discovery-based student worksheet in geometry materials. The writing of a worksheet was adjusted to guided discovery, core competencies, and basic geometry competencies. The implementation of the guided discovery method in mathematic learning was in line with curriculum 2013. Through the guided discovery-based student worksheet in developing their spatial intelligence, students were provided the opportunity to compile, process, organize data provided by the teacher. Through the guided discovery process, students are required to use ideas and understanding that have been owned to find a new thing. In the process of finding a concept, the teacher can help to provide solution instructions, which directs students to be able to construct concepts.

b. Design Stage

In the design stage, we design the worksheets. Firstly, we elaborate on the characteristics of the guided discovery method, main competencies, basic competencies, and indicators geometry, especially in the plane figure topic. The second was determining student worksheet structure that will be developed, including preface, instructions table of contents, chapter pages, concept maps, steps of the guided discovery model, and sub-chapters of materials consisting of the study guide, basic competencies, indicators, supporting information, and tasks/activities. The third was designing research instruments, including validity instruments (validation sheet), practicality instruments (implementation observation sheet, student and teacher response questionnaires), and effectiveness instruments (student and teacher activity observation sheets, mathematics learning outcome tests).

c. Development Stage.

In this stage, the first thing to do was write a worksheet according to the design stage. In the student worksheet writing process, the researcher referred to guidelines of student worksheet writing seen from the components of content feasibility, language, presentation, and graphics. In the student worksheet writing process, several references were used, mainly regarding the materials written in the student worksheet. Student worksheet writing used several computer application programs, one of which is Microsoft Office Word. This student worksheet writing process results in a worksheet draft validated before being tested on the students. Student worksheet that has been developed consisted of cover, preface, instructions of using student worksheet, table of contents, chapter pages, concept maps and steps of the guided discovery model, keywords, basic competencies, learning experiences, concept maps, and exercises.

Furthermore, making research instruments to measure the quality of the student worksheet include validity, practicality, and effectiveness. The validity of the student worksheet used student worksheet validation sheet, the practicality of student worksheet used implementation observation sheet, student and teacher response questionnaires, and effectiveness of student worksheet used student and teacher activity observation sheet during the learning process and mathematics learning outcome tests. Before the student worksheet and study instruments were tested, the instruments were validated first by two expert lecturers as validators.

Table 1 The Results of Validation on All Components

Components	Component Average	Description
Contents	3.2	Valid
Language	3.1	Valid
Presentation	2.9	Valid
Graphics	3.2	Valid
Average of All Components	**3.1**	**Valid**

The validation results obtained that the average validator assessment for all components of student worksheet feasibility is 3.1 with a valid category. After the student worksheet was validated and stated feasible to be tested, the draft was revised according to the comments and inputs from validator I and validator II.

d. Implementation Stage

In this stage, the student worksheet and instruments of the study in the observation sheet were tested on 35 8th-grade students and a teacher in Sungguminasa Junior High School of Gowa Regency. The learning occurs in 3 meetings using the guided discovery method and worksheet. In the learning process at the meeting I, the students were still confused about using the worksheet given by the teacher. Moreover, in the learning process at the meeting, I did not sufficiently demonstrate the guided-discovery method. The teacher still tended to directly give the existing concepts in the geometry flat side materials without providing opportunities to students to search and find their own concepts. However, it was different from the learning process in meeting II and III. It can be seen during the learning process that students have been more active in doing activities in the student worksheet. At the same time, the teacher acts as a facilitator during the learning process.

e. Evaluation Stage

After the student worksheet trial, the researcher then conducted an evaluation. In this stage, the researcher analyzed research data. Data analysis of practicality was the results of student worksheet implementation observation and student and teacher response questionnaire data. The results are presented in the following table:

Table 2 The Results of Data Analysis of Implementation Observation Sheet

Observation Aspects	Aspect Average	Description
Steps of Guided Discovery	1.47	Partially Implemented
Social Interactions	1.10	Partially Implemented
Reaction Principle	1.17	Partially Implemented
Average of All Aspects	1.24	Partially Implemented

Table 3 The Results of Data Analysis of Student Response Questionnaires

Aspects	Average Percentage (%)	Description
Appearance	68.71	Quite Positive
Material Presentation	73.81	Positive
Advantage	73.04	Positive
Average Percentage of All Aspects	**71.85**	**Positive**

Table 4. The Results of Data Analysis of Teacher Response Questionnaires

Aspects	Average Percentage (%)	Description
Appearance	85.00	Very Positive
Material Presentation	83.33	Positive
Advantage	83.33	Positive
Average Percentage of All Aspects	**83.89**	**Positive**

Data analysis of practicality obtained an average score for all aspects in student worksheet implementation observation of 1.24 with partially implemented category.

Meanwhile, the average percentage of all aspects in the student response questionnaire was 71,85% with positive category, and the teacher response questionnaire was 83.89% with positive category. Therefore, it can be stated that in the implementation of student worksheet components, the student and teacher responses to the developed student worksheet have been met. Thus, the guided discovery-based student worksheet with geometry materials is stated to be practical.

Table 5. The Results of Data Analysis of Student Activities

No	Aspects of Student Activity Observation	Percentage of Student Activity on Meeting		
		1	2	3
1	Listening to the teacher's explanation about the learning objectives.	65.71	68.57	66.86
2	Mentioning things around them that resemble lane figures.	66.29	65.71	62.86
3	Listening to the teacher's explanation regarding the importance of learning plane figures.	64.00	70.29	68.00
4	Formulating problems in the Student Worksheet.	65.71	62.29	61.71
5	Making hypothesis answers to the case given.	62.86	63.43	68.00
6	Searching for information from other sources related to case examples given.	64.57	65.14	67.43
7	Asking groupmate or teacher regarding the steps for solving cases in Student Worksheet.	60.57	65.71	62.86

8	Comparing the results obtained with the temporary answers that have been formulated before.	66.86	65.71	67.43
9	Drawing conclusion regarding steps	62.29	57.14	61.71
	Calculating the surface area and volume of the flat side.			
Average Percentage of Each Meeting (%)		**64.32**	**64.89**	**65.21**
Description		**Good**	**Good**	**Good**
Average Percentage of All Meetings (%)			**64.80**	
Description			**Good**	

Table 6. Distribution of Frequency and Percentage of Post-test

Categories	Interval	Frequency (f)	Percentage (%)
Very High	91-100	1	2,86
High	75-90	25	71,43
Moderate	60-74	6	17,14
Low	40-59	3	8,57
Very Low	0-39	0	0,00
Total		**35**	**100**

Moreover, the data analysis of effectiveness obtained that the percentage average of student activities for all learning meetings was 64.80%, which is in a good learning activity category, and activities of the teacher in managing the learning process were 3.76 with a good category. Meanwhile, the mathematics learning outcome tests obtained 25 students (71.43%) of 35 students that have obtained a minimum score of 75. Therefore, it can be stated that student and teacher activities and mathematics learning outcomes of students after participating learning process using the developed student worksheet have been met. Thus, the guided discovery-based student worksheet to develop spatial intelligence on geometry materials is stated effectively.

4. CONCLUSION

This development research was conducted to determine the development process of the guided discovery-based student worksheet to develop spatial intelligence on valid, practical, and effective geometry materials in 8th-grade students of 1 Sungguminasa Junior High School. The development model used was the ADDIE development model consisting of 5 stages: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation.

The following explains the stages carried out in developing the guided discovery-based student worksheet to develop spatial intelligence on valid, practical, and effective geometry materials. In the analysis stage, the activity carried out was analyzing the needs of students and curriculum in accordance

with geometry flat side materials. Based on the interview results with the teacher and students, it was obtained that the student worksheet contains a definition, brief description, and the same exercises with examples so that students have difficulty solving problems that are different from the example of questions. Meanwhile, the curriculum analysis is based on the core competencies and basic competencies, according to Curriculum 2013 for geometry flat side materials. In the Design Stage, the activities conducted were compiling a map of student worksheet needs and determining student worksheet structure. Compiling the map of student worksheet needs was conducted by considering the characteristics of guided discovery, core competencies, basic competencies, and indicators of competence achievement.

Moreover, the student worksheet structure generally includes cover, competencies to be achieved, learning experiences, concept maps, characteristics of guided discovery, steps of guided discovery, activities, and exercises. In the Development Stage, the activities conducted were student worksheet writing, research instrument writing, validation of research instrument by expert lecturers, revision of research instrument, student worksheet validation, and student worksheet validation. After the making, validation, and revision processes, the research instruments and the valid student worksheet were obtained. In the implementation Stage, activities conducted were conducting a trial of the guided discovery-based student worksheet on 35 8th-grade students in 1 Sungguminasa Junior High School and the teacher

through the learning process with the guided discovery method. The learning occurs in 3 meetings using the guided discovery method and worksheet. In the Evaluation Stage, activities conducted were analyzing research data collected in the form of student worksheet implementation observation, data of student and teacher activities observation during the learning process, data of student and teacher response questionnaires, and data of mathematics learning outcome tests. Data analysis were conducted to observe the practicality and effectiveness of using developed student worksheet. Based on the results of data analysis in this stage, the guided discovery-based student worksheet with effective and practical geometry flat side materials was obtained.

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