Design of Student Worksheet Based On Discovery Learning to Improve the Ability of Mathematics Reasoning Students of Class VII Junior High School

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Abstract. The reasoning is one of the important aspects that must be mastered by students in learning mathematics in the 4.0 industrial revolution. The low mathematical reasoning abilities of students will have an impact on the difficulties of students in achieving learning goals and learning outcomes of mathematics. This article aims to design student worksheets based on discovery learning models to optimize students' mathematical reasoning. This research is development research using submodel of ADDIE development (Analysis, Design, Development, Implementation, and Evaluation). The submodel development procedure consists of two stages: analysis and design. The subjects of this study were seventh-grade junior high school students. The object of this research includes curriculum, student characteristics, evaluation of teaching materials. The instruments of data collection in this study were essayed items and interview guidelines. The data analysis technique used in this study is qualitative data analysis. The results of the study are a) at the analysis stage it is known that the learning process is still not meaningful, the learning method used by the teacher has not been able to facilitate students to reason, the student worksheet used does not yet cover all competency indicators in the school. b) the results of the student worksheet design consist of: cover, preface, table of contents, core competencies, basic competencies, indicators of achievement of competencies, material, practice questions based on discovery learning, and problem training. This research can be extended to the stages of development, implementation, and evaluation to produce valid, practical and effective student worksheets.

1. Introduction

The reasoning is the process of thinking to get decisions and refer to content that we have not known before and relate it to new experiences to get valid conclusions [1],[2]. Saleh et al. [3] defining reasoning is the ability of students to connect some information and arguments needed to draw a valid or accountable conclusion. Faradillahet al. [4] Mathematical reasoning is a mathematical thought to make generalizations with an idea to get the right conclusions. Dewi&Harahap [5] define reasoning as a thinking activity in making a new statement based on facts that have been studied previously, so that reasoning can be interpreted as a deductive to inductive conclusions by linking ideas or ideas that have been known beforehand and linking them with new experiences so that conclusions can be drawn which can be accounted for.

The reasoning is one of the important aspects that students must have in learning mathematics in school [6]. As in [7]through reasoning students can build their knowledge and skills in solving mathematical problems. Problem-solving becomes an important part of mathematics learning, so reasoning is also an important part of solving problems in mathematics. The reasoning is not only a process of learning mathematics but the reasoning is a strategy in learning mathematics[8].Shivakumar&Suvarma [9] explained that reasoning ability becomes one of the main abilities that students must possess to solve problems in learning mathematics, for that reasoning
ability must be one of the special concerns in the world of education, especially in mathematics learning. Mathematics learning material can only be understood by using reasoning while reasoning can be sharpened by learning mathematics for that mathematics and reasoning are two aspects that cannot be separated [10]. Someone in everyday life must own the importance of reasoning according to [11] not only in mathematics learning at school but also the reasoning ability. The reasoning ability will help someone to get a solution in solving the problems of daily life.

However, TIMSS data [12] shows that Indonesian students get 45 ranks from 50 countries participating in the TIMSS study. The reasoning aspect is the lowest aspect obtained by Indonesian students, which is 20% of all domains tested. From the preliminary research conducted in Berbah Middle School 2 Yogyakarta, it was found that students’ mathematical reasoning was still low, students’ mathematics learning processes were less meaningful, and learning tended to be abstract. Learning is given classically through the lecture method without seeing much about the possibility of applying other methods in accordance with the type of material.

The main factors that influence students’ mathematical reasoning are the learning strategies that teachers do in learning mathematics to be the dominant factor in improving students’ mathematics learning [13]. Hidayat et al. [14] one of the factors that influence students in working on math problems is that students have not been able to use their reasoning properly. Learning strategies provided by the teacher still cannot stimulate students to hone their reasoning skills so that when students are given a problem that has a high level of difficulty students experience difficulty in working on it. Many teachers are reliable in teaching mathematics but have not included understanding and planting concepts. Mathematics learning is still dominated by a memorization system, so students have not mastered the concept of mathematics learning and make students difficult to understand [15].

Students’ mathematical reasoning can be improved using learning models or strategies that focus on the teacher being changed to focusing on students so that they can stimulate students to master the concept of mathematics learning rather than rote learning. Learning models that can be used to improve students’ mathematical reasoning are discovery learning models [16] Discovery learning can be oriented towards maximal student involvement in school learning activities. This learning model is student-centered, and the teacher plays a role in making learning designs. In the learning process, the teacher does not present the learning material in the final form. The teacher only presents a portion of the material, and the rest is left to students to search for themselves so that students better understand the concept of learning.

Discovery learning is a learning model where students are actively involved in the learning process in this learning model students are inculcated with concepts such as learning, observing, explaining, measuring, clarifying and making a conclusion [17]. Suphi&Yaratan [18] the use of discovery learning models can increase students’ curiosity when learning is underway and also by using discovery methods students can also be directly involved in the learning process, this shows that students who use discovery models in learning have a higher level of a positive domain when examining.

To apply the discovery learning model, there must be support so that the implementation of the discovery learning model can be realized properly as said by [19] there are still many students who have weaknesses in reasoning and mathematical representations in understanding indicators of both abilities. For this reason, it is necessary to develop appropriate learning tools using learning methods that can improve mathematical reasoning and representation. Dewi&Harahap [5] the development of teaching materials must be a concern in the learning of mathematics. Developing appropriate teaching materials will encourage students to develop mathematical skills in context to improve students’ mathematical reasoning. Putra et al. [20] developing teaching materials for student worksheets can improve mathematical problem posing abilities. Students who use the development of students’ worksheets are said to have the ability to solve mathematical problems posing quite well than before the development of student worksheets.

This article aims to answer the following questions. First, how is the learning process in class. Second, what does the teacher use the learning model. Third, how to know the level of students’ mathematical reasoning. Fourth, how to design student worksheets based on discovery learning to
improve mathematical reasoning. This article consists of four parts. The first part outlines the introduction. The second section describes the research method. The third section provides results and discussion. The fourth section presents conclusions and further expansion of research.

2. Research Methods
This research is development research to produce the design of Student Worksheets based on discovery learning. The development model used is the ADDIE Model (Analysis, Design, Development, Implementation, Evaluation).

![Figure 1. ADDIE model [21]](image)

The development procedures in this study include analyzing, designing, developing implementing, and evaluating. This study is limited to the stage of designing student worksheets based on discovery learning on the subject of the set. This research was conducted in Berbah 2 Public Middle School Yogyakarta. Subjects in this study were seventh-grade students of Berbah State 2 Junior High School Yogyakarta. The object of this research includes curriculum, student characteristics, evaluation of teaching materials. Data collection instruments used in this research are essay questions and interview sheets. Essay sheet is used to measure the extent to which students' mathematical reasoning abilities while the interview sheet is used to find out what factors influence students' mathematical reasoning and to find out what needs students need.

Data analysis techniques used in this study used qualitative data analysis, namely data reduction, data presentation, and conclusion drawing. Data obtained from the results of observations and interviews conducted in schools were then summarized and concluded.

3. Results and Discussion

3.1 Analyse Phase
The stage of analyzing the data was carried out by theoretical and empirical analysis to determine the characteristics of students. The results of observations and interviews indicate that the learning process is still less meaningful or given students classically only receive what is explained by the teacher and have not been able to be actively involved in the learning process. The teacher still has not applied a learning model that facilitates students to reason. From the preliminary research conducted, many students have not been able to use mathematical reasoning to the fullest. Table 1 math reasoning scores.

| Value | Category   | The number of students | Percentage |
|-------|------------|------------------------|------------|
| 81 -100 | Very good | 0                      | 0%         |
| 61 - 80 | Good       | 7                      | 23%        |
| 41 - 60 | Enough     | 11                     | 35%        |
| 21 - 40 | Less       | 10                     | 32%        |
| 0 - 20  | Very less  | 3                      | 10%        |

**Table 1:** Scores of students of mathematical reasoning
Based on table 1 it can be seen that as many as 3 students or 10% of those who take reasoning tests are still in the category of very less, students are still unable to follow the indicators of reasoning. A total of 10 students or 32% were in the category of lack of students still giving incorrect answers and did not provide a reason for how the answers were obtained. As many as 11 students or 34% are in the category enough students have been able to do mathematical manipulation, submit allegations but students have not been able to find patterns or traits to explain why the method used is correct and drawing a conclusion or proof of the truth of a solution is still incorrect. A total of 7 students or 23% have good mathematical reasoning skills or have followed the rules contained in the indicator of reasoning students have not been able to conclude so that their answers are still inappropriate. While the average score of students' mathematical reasoning test scores was 46.7% of 31 students, who took a mathematical reasoning test.

From the results of interviews with teachers, the student worksheets used do not include all competency indicators used in the school and are not presented in a structured manner so that they cannot guide students to be more active in the learning process. While the Student Worksheet using discovery learning models is structured, and indicators are used in accordance with the curriculum in the school. It is expected that student worksheets using discovery learning models can stimulate students to be more active in learning and also can improve students' mathematical reasoning and make it easier for teachers to provide assignments in mathematics learning.

3.2 Design Stage
At this stage, the researcher makes a product design for the Student Worksheet that matches the analysis results at the defining stage. The student worksheets are composed of the following components: cover, preface, table of contents, core competencies, basic competencies, and indicators of achievement, material, sample questions using discovery learning models, practice questions. The following steps to design student worksheets in helping improve mathematical reasoning in the set material can be seen in the following figure:

3.2.1 Cover Student Worksheet. Cover Student Worksheet made more colorful to attract the attention of students to learn mathematics. Figure 2 is the cover of the student worksheet.
3.2.2 Preface

In designing the Student Worksheet, a preface is made to bring the reader to the contents and descriptions contained in the Student Worksheet. As well as arousing students’ interest to study the Student Worksheet more deeply. Figure 3 is a design preface

3.2.3 Table of contents

![Figure 4. Table of contents](image1)

3.2.4 Core competencies, Basic Competencies, Achievement Indicators. Core competence is a form of quality that must be possessed by students after completing school education. While the basic competencies are designed for students’ reference about what must be achieved in learning the set contained in the Student Worksheet. While indicators are made to show the achievement of a basic competence after studying the Student Worksheet. Figure 5 is the core competencies, basic competencies, and indicators of achievement

3.2.5 Material and exercises

The material and exercises on this Student Worksheet are made in accordance with the Discovery Learning model. Theory and images are explained more communicatively and the designs used are more colorful so that they are expected to optimize students’ mathematical reasoning. While the practice questions used to follow the steps in the discovery learning model. This step consists of:

a. Presenting questions or problems In the first phase, students identify problems and write them on the Student Worksheet. In this phase, the teacher divides students into several groups.

b. Make a hypothesis

![Figure 5. Core competencies, Basic Competencies, Achievement Indicators](image2)
In the second phase students discuss with friends a group to devote their opinions in forming hypotheses, the teacher guides students in determining the hypothesis.

c. Design an experiment
In the third phase of the teacher, each group determines the steps in accordance with the hypothesis that will be carried out, the teacher guides students to sort the steps in solving the problem.

d. Conduct discussions to get information
In phase four students hold joint discussions with the teacher to get information through discussion.

e. Collect data and analyze data
In phase five students are asked to collect and analyze data from information obtained from the teacher and from group friends to convey the results so that they can provide information to other groups about what has been found

f. Conclusion
In the last stage the students to make the conclusion of all the steps that they have done.

Figure 6. is the design of materials and practice questions based on discovery learning

Figure 6. Material design and exercises based on discovery learning
3.2.6 Exercise question. Exercises questions are used to determine the level of student mastery of the material and to measure the students' mathematical reasoning skills after participating in learning by using Student Worksheet Discovery-Based Learning. The exercises questions used follow mathematical reasoning indicators. Figure 9 design exercises questions.

![Figure 7. exercise question](image)

4. Conclusions and Recommendations
This study analyzes the needs of student worksheets that are in accordance with the learning model, student characteristics, and learning material. The learning process is still less meaningful and given classically. Students only accept what is explained by the teacher and cannot be actively involved in the learning process. The learning method used by the teacher has not been able to facilitate students to reason and is still dominated by the memorization system so that students cannot understand the concept of learning. Test results show that there are still many students who have not used reasoning to the fullest. The student worksheet used does not include all competency indicators in school. Student worksheets are not presented in a structured manner so that they cannot lead students to be more active in the learning process. In addition, this study designs discovery learning-based student worksheets which include: cover, preface, table of contents, core competencies, basic competencies, indicators of achievement of competencies, material, discovery learning-based practice questions, and practice questions.

In accordance with the ADDIE research model, this research can be developed in development, implementation, and evaluation. For further research so that the design of student worksheets based on discovery learning that has been made can be validated by experts namely material experts and media experts to meet the criteria of practicality and their effectiveness to be implemented in schools. Student discovery based worksheets are expected to improve students' mathematical reasoning.

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