Design Of Mathematics Worksheets Based On Guided Inquiry Model To Improve Mathematical Connection Skills

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Abstract: The ability of mathematical connections is the ability to connect or associate problems related to mathematics, the mathematical concept itself or with concepts outside of mathematics. The guided inquiry model can improve students' mathematical connection skills. This study aims to design teaching materials in the form of student student worksheets, which contain activities following the steps of the guided inquiry model and indicators of students’ mathematical connection ability. The research uses the ADDIE development method. The research subjects were students of class VIII SMPN 12 Yogyakarta. The object of this research is the ability of mathematical connections, guided inquiry models, and teaching materials in the form of student student worksheet. Data collection instruments used interview guidelines, observation sheets, and validation sheets. The results of the study can be concluding that the student worksheet design based on guided inquiry models to improve mathematical connection skills developed through the ADDIE development method has a component, namely: cover, preface, table of contents, Core Competencies, Basic Competencies and Indicators of Achievement of Competencies (KI, KD, and IPK), instructions for use, concept maps, student worksheet activities, evaluations, and author profiles. student worksheet has been validated by two validators and has been categorized as feasible with some improvements previously.

Index Terms: ADDIE Development Method, Guided Inquiry, Mathematical Connection Ability, Student Worksheet

1 INTRODUCTION

Mathematics is a universal science and is the basis for other sciences or as a tool in solving everyday problems. The ability associated with higher-order thinking is a mathematical connection [1]. This subject is in accordance line with one of the goals that can achieve in the process of learning mathematics is the ability of students' mathematical connections [2] Besides mathematics also cannot be separated from science other than mathematics and problems that occur in everyday life [3]. Without a mathematical connection, students must learn and remember too many partial mathematical concepts and procedures [4]. Furthermore, mathematical connection ability is the ability possessed by students in linking or connecting problems related to mathematics [5] and connection ability can help students in connecting mathematical concepts to be learned with prior knowledge [6]. A mathematical connection is one of the essential abilities. It needs to be had by students [7], a mathematical connection is one of the essential abilities. It needs to be had by students [7] because if students can link mathematical concepts, their mathematical understanding will be deeper and last longer [8], this is by supporting the existence of mathematical connection ability indicators namely: 1) Finding relationships between various representations of concepts and procedures. 2) Understand the relationship between mathematical concepts. 3) Applying the relationship of mathematical topics in real life [9]. Therefore, the ability of mathematical connections becomes very important and is needed by students so that they can understand and have no difficulty in learning mathematics to connect the concepts of matter [10].

Based on the results of the Program for International Student Assessment-Organization for Economic Cooperation and Development (PISA-OECD) in 2015 showed that Indonesia's position was ranked 63 out of 72 other countries that participated with a mathematical value of 386 out of the value of 500 from 500 which became the international standard [11]. One of the causes of Indonesia's low achievement in mathematics is the lack of students' ability to connect mathematical concepts that are related to one another [12]. The profound mathematical connections of students, especially those that occur in class VIII SMP Negeri 12 Yogyakarta. Based on the results of observations that have been made, the conclusion obtained by researchers is that students are less able to link the material being studying with the information they have previously obtained, and still have difficulty in connecting between contextual problems with learning material. Among the causes of the lack of students' mathematical connection ability is the learning process that still uses ordinary learning. While the purpose of education at this time is that students can learn independently [13] and students must be directly involved in the learning process [14]. Independent learning means that students can solve complex problems not only from existing definitions [15]. Students are also guiding to investigate a concept in the process of learning by doing [16]. One model that fits this goal is the guided inquiry model. In the guided inquiry model, students are required to be more active in learning, not just passively in learning, and rely on what is taught by the teacher [17]. The guided inquiry model is a learning model that is constructivist, which means students are required to find meaning in what is being learned [18]. In other words, students are directing to explore and hypothesize problems given in a learning process [19]. In more detail, it is explaining that the guided inquiry model is learning that will make students more active, creative, critical and able to develop their ideas freely and deeply, so that they can express their imagination and thoughts [20]. Furthermore, in the guided inquiry model, students are guided to find concepts in the learning process
from various sources of information so they can find new understanding [21]. The guided inquiry model has advantages, including: (1) Students will understand basic concepts and ideas better; (2) Assist in using memory or cognitive abilities and connecting in the lessons being studying; (3) Encouraging students to take the initiative and formulate their hypotheses; (4) provide deep satisfaction with what has been invention; (5) The learning process becomes more meaningful [20]. The steps taken in the guided inquiry model are: (1) Planning Phase; (2) Retrieving phase; (3) Processing phase; (4) Creating Phase; (5) Sharing Phase; (6) Evaluating phase [21]. From the phases contained in this guided inquiry model makes students more active and enthusiastic about finding information that is still related to the topic have been taught, so students are required to connect concepts related to mathematics and concepts that are relating contained in mathematics itself [22]. In the application of the guided inquiry model, the instructional media used by the teacher can also help students in finding solutions to a problem presented [23]. From the results of previous studies, it can be concluding that the guided inquiry model can influence and enhance some learning abilities of students. According to Maarif, the guided discovery method can improve students' mathematical analogy ability to be better than students who receive learning by the expository method [24]. Furthermore, the activities of students in learning the Open-Inquiry Approach experience a proper development cycle. Positive responses of students to the Open-Inquiry Approach can be seen from the attitude of students who are actively and attractively involved directly in the learning process [25]. From several relevant findings regarding the analysis of the characteristics of mathematical connection ability and guided inquiry learning model provides predictions that the guided inquiry learning model plays a proper role in improving students' mathematical connection ability. In addition to improving the ability of mathematical connections required teaching materials. Because basically, teaching materials that are arranging systematized based on the principles used by teachers can facilitate students in learning a material [26]. In this research, teaching material can develop a student worksheet. Student worksheets provide activities that help students to find solutions to a given problem [27]. Besides, from the results of the researchers’ validation of the student worksheets, that were already in school, there were found some short-comings, including the cover design does not represent teaching materials, the illustrations that were displayed did not match the material. The student worksheets do not contain pictures related to the material so that it did not interest students in learning, completeness of information in the form of instructions for use student worksheets do not contain in the student worksheets, this makes it difficult for students to use it. Therefore, based on the problems found in the field and the support of information obtained from various sources above, the researcher is interested in designing and developing the design of teaching materials in the form of student worksheets appropriate with the characteristics of students with the guided inquiry model, this is expecting to be able to improve students' mathematical connection skills.

2 RESEARCH METHOD

This type of research is development research, and this study uses the ADDIE development model. ADDIE has five stages: Analysis, Design, Development, Implement and Evaluate [28],[29],[30],[31],[32],[33]. The first stage is Analysis. At this stage, an analysis of the needs of students relating to the skills, knowledge, and abilities possessed by students. In the second stage designs, in this stage, the researcher develops a plan in more detail, which includes the selection of learning methods, learning strategies, and learning media. In this stage, the researcher also develops instructional objectives, conducts testing, and drafts instructions. The next stage in development, at this stage, the development of the design that has been making. The fourth stage is the Implementation stage. In this stage, the teaching system that has been designing and developing is then applying to the learning process. The last is the Evaluate stage, in this stage is an effort to identify the shortcomings of the previous processes, then to become a recommendation for continuous improvement [34].

The ADDIE development model process.

The objects of this study were students of class VIII of SMP Negeri 12 Yogyakarta. The research instruments included interview guidelines, observation sheets, and validation sheets. The purpose of this study is to design teaching materials in the form of student worksheets. In the analysis phase, the researchers made observations related to the curriculum, material, characteristics of students, and the needs of students' teaching materials and interviews with related subjects. Next, the researcher makes the design of the student worksheet by including the learning objectives and the student activity framework. The design of student worksheets that were made was validated by experts and given an assessment to be later revised so that the design of teaching materials is feasible to use.

3 RESULTS AND DISCUSSION

3.1 Analysis

At the initial stage in the ADDIE development model is to analyze the needs of students’ teaching materials. From the results of observations and interviews conducted by researchers and support of data and information obtained, there are several findings, including:

1. Students need teaching material that can help them in linking the material being studied with information that they have previously obtained. So the teaching materials
needed by students are teaching materials that can improve students' connection skills
2. Teachers need teaching materials that are appropriate to the characteristics of students
3. The teacher states that students still have difficulty learning the material to build flat side spaces, students have difficulty in finding and applying the concept of surface area and volume because in the student worksheets they only contain material, examples of questions and questions
4. Learners need interesting teaching materials so that they can increase interest in learning, because teaching materials that do not contain pictures and attractive colors add to the boredom of students in learning.

3.2 Student Worksheet Design

3.2.1 Cover Design
Figur 2 is a student worksheet cover. The cover includes the field of study, the learning model used, the title of the material, and the name of the author.

Fig. 2. Cover Design

3.2.2 Table of Contents
Fig. 4 below shows the table of contents. The table of contents lists the chapters and sub-chapters of the material along with the pages in the student worksheet. With the table of contents, it is easier for users of student worksheets to find subject matter.

3.2.3 Core Competencies, Basic Competencies and Indicators of Achievement of Competencies (KI, KD and IPK)
Figure 5 displays the KI, KD and IPK as shown below:

Fig. 5. KI, KD, and IPK

3.2.4 Instruction for Use
Figure 6 below is a guide to using student worksheets and the order of use. Directions and sequence of use of student worksheets aim to make it easier for users to read symbols that represent the steps of guided inquiry learning models and indicators of mathematical connection ability.

Fig. 6. Instruction for Use
3.2.5 Concept Maps
The concept map presented in student worksheets aims to guide and make it easier for users to know the outline of the mapping of material to be studied. The concept map can be seen in Figur 7 below:

![Fig. 7. Concept map](image)

3.2.6 Student Worksheet Activities
Figure 8 below contains the activities related to the material. The activities presented are following the steps of the guided inquiry model and indicators of mathematical connection ability.

![Fig. 8. Learning activities](image)

3.2.7 Evaluations
Evaluations in Student worksheet are presenting in the form of essay questions. The evaluation aims to find out the results of the activities that have been carryout previously. Evaluation design caning be seen in Fig 9 below:

![Fig. 9. Evaluation](image)

3.2.8 Author Profile
Fig 10 contains the author's profile. The author's profile is locating behind the student worksheet's. The author's profile contains a brief written biography and educational history of the author.

![Fig. 10. Profile of the author](image)

3.3 Validation Results
Before developing a student student worksheet's design, it must have proper and decent quality. Therefore, the design of the student worksheet was validated by experts to test its feasibility. In this study, the student worksheet design was validating by Yuni Octaria, S. Pd as a mathematics teacher at SMK Penerbangan Radin Intan Bandar Lampung and Rea Dewanti, S. Pd as a mathematics teacher at SMP Negeri 36 Bandar Lampung. The following is table 1, which contains suggestions and comments on the results of validation from the two validators.

<table>
<thead>
<tr>
<th>No</th>
<th>Suggestions and Comments</th>
<th>Revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The background used should not be more dominant so that students are more focused on the material.</td>
<td>Already repaired</td>
</tr>
</tbody>
</table>

![Table 1: Suggestions and Comments by Validators](table)

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Each activity has not yet mentioned the learning objectives

Presentation of information is incomplete, and there are some that do not have student worksheet's pages

Table 2

<table>
<thead>
<tr>
<th>No</th>
<th>Validator</th>
<th>Score</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yuni Octaria, S.Pd.</td>
<td>78</td>
<td>worthy</td>
</tr>
<tr>
<td>2</td>
<td>Rea Dewanti, S.Pd.</td>
<td>80</td>
<td>worthy</td>
</tr>
<tr>
<td></td>
<td><strong>Total Score</strong></td>
<td><strong>158</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Score Avarage</strong></td>
<td><strong>79</strong></td>
<td>worthy</td>
</tr>
</tbody>
</table>

Based on the result, the assessment given by the two validators in Table 2 above. Validator 1 gave a score of 78, and validator 2 gave a score of 80. From the two validators who validated the student worksheet design obtained an average of 78.5, the student worksheet design had a decent category, in other words, the student worksheet design had an excellent quality to be developing as teaching material.

4 CONCLUSION

From the results and discussion above, it can be concluding that the student worksheet design based on the Guided Inquiry model to improve the ability of mathematical connections using the ADDIE development method. Components in student worksheet consist of a cover, preface, table of contents, Core Competencies, Basic Competencies) and Competency Achievement Indicators, usability instructions, concept maps, student worksheet activities, evaluations, author profiles. In these activities, the section contains the steps of the Guided Inquiry model and indicators of mathematical connection ability. Furthermore, the student...
worksheet design was validated by two different validators to be later corrected by the author student worksheets following the suggestions and comments provided by the validator. After being corrected by the authors, the two validators gave an assessment and obtained an average with a decent category.

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3. The two validators who have validated the student worksheet design and provided constructive suggestions and comments to produce a student worksheet design with an appropriate category for later development into teaching material.

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