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Analysis and Design of Mathematics Student Worksheets Based on PBL Learning Models to Improve Creative Thinking

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Abstract

This study aims to design a student worksheet with a problem-based learning model of learning to improve students' creative thinking skills. This research is a descriptive study with a qualitative approach. Subjects of this study are teachers and students of class XII MAN REO in Nusa Tenggara Timur. The object of research is creative thinking, problem-based learning and student worksheets. Data collection instruments using interview and observation guidelines. Data were analyzed using Miles & Huberman data analysis. Results showed that competency standards, basic competencies, and indicators of competency achievement were by the 2013 curriculum. Students' creative thinking skills were still low. Students have difficulty with material opportunities. Problem-based learning is one model that can be applied to improve students' creative thinking skills. Teachers need a student worksheet that is compatible with the learning model. Student worksheets that can develop creative thinking skills are not yet available. Teachers need a student worksheet that is by the characteristics of students and can improve students' creative thinking skills. This research can be continued in the Implementation and Evaluation phase.

Keywords: *creative thinking, design development, problem-based learning, student worksheets*

1. Introduction

Mathematics is one of the subjects that has an important role in education [1]. Mathematics takes an important role as a tool to regulate our daily lives in society [2]. The most important thing in learning mathematics is understanding the concepts of the material presented. To understand mathematical concepts students must have special competencies, the competence in question is creative thinking [3]. Creativity is very important in learning mathematics [4]. Creative thinking is one of the important abilities in solving problems. Increasing the ability to think creatively, student achievement is also expected to increase [5]. Facing the challenges of the industrial revolution 4.0 students must have creative thinking skills [6]. Creativity is a skill to find new thoughts. Critical thinking skills must be possessed by students to answer the challenges of 21st-century learning [7]. The development of student creativity is also one of the most important educational goals [8]. In the 2015 PISA (Program for International Student Assessment) research, Indonesia ranked 62 out of 70 countries participating in PISA [9]. The average value of mathematics achievement in all countries is 490; meanwhile, the average value of mathematics students in Indonesia is 386. Based on these data, Indonesia's ranking is still far below the international average. This means that the mathematical abilities of Indonesian students are still low. The process of learning mathematics in elementary schools needs to be improved. Mathematical learning must be designed according to the objectives stated in the curriculum [10]. Creative thinking skills need to be improved through teaching materials. Good and innovative teaching materials can increase student creativity [11]. Learning resources or teaching materials that can help students learn independently are one of the important roles in the learning process. One of the goals in learning is that students can understand the concepts of learning material being delivered [12]. The teacher must be able to prepare teaching materials appropriately so that the learning process can improve students' creative thinking. One of them is

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by providing student worksheets well [13]. Student worksheets are created to help students relate problems with the subject matter to everyday life [14]. Students need worksheets as teaching material that can make them actively and creatively participate in learning mathematics and can help them find learning concepts through solving everyday problems [15]. Student worksheets are guides used by students to conduct learning activities [16]. Learning with student worksheets allows students to learn faster in completing one or more basic competencies (KD) because students can learn them first, and student worksheets that are developed contain material and are rich in practical questions that will guide students in finding concepts so that the student worksheets provided can direct students to solve mathematical problems related to real-life [17]. Student worksheets are used because they are fewer, more convenient and summarize the material along with questions to help students in mathematical communication skills [18]. Based on interviews with mathematics subject teachers at MAN REO East Nusa Tenggara, schools already have a student worksheet but have not been able to fully improve students' creative thinking skills. Student worksheets in school have not included clear indicators, all fonts are the same, there are no differentiators, there are no instructions for using the worksheets of students and the material illustrations are absent, the layout colors are less attractive. Teachers need to design student worksheets that are innovative and can make students able to improve their creative thinking abilities.

Efforts to improve creative thinking skills in addition to making interesting teaching materials can be done by choosing appropriate and innovative learning models. The process of learning activities that are rational, fun, and full of challenges are arranged in the learning process. Learning activities must motivate students not to be passive, facilitate students to be creative, and become independent following with the desires and abilities of students, and the physical and psychological development of students [19]. Problem Based Learning is one of the learning models that is suitable for active learning and independent learning [20]. Problem-based learning centers on student learning [21] and can make learning mathematics more effective and innovative because students tend to focus on their interests and talents and are more active in the learning process [22]. Problem-Based Learning has five steps of learning, namely: (1) students' orientation to problems, (2) conditions for students to learn, (3) guiding individual students and groups of investigations, (4) developing and presenting work results, and (5) analysis and evaluation of the problem-solving process [23]. Problem-Based Learning was chosen because (1) linking problems with real-life (2) encouraging students to play an active role in learning activities, (3) encouraging the use of various learning approaches, (4) giving students the opportunity to make choices and effective ways of learning (5) encourage learning with other students, and (6) to achieve quality education. In Problem-Based Learning, students work in small groups and can identify given to solve problems [24]. Researchers assess the learning resources in the form of modules taught in schools. The value of validation is 78.5. As for some of the deficiencies found are (1) Student worksheet has not encouraged students to actively ask questions (2) The appearance of student worksheet does not match the illustrations, (3) Student worksheet does not display pictures that clarify the material, (4) The pictures and illustrations on the student worksheet are less attractive to students, (5) The Student worksheet have not made it easy for students to understand the contents of the material. Based on the description above, the researcher intends to make teaching materials in learning. The purpose of this study is to design teaching materials in learning opportunities using the Problem-Based Learning (PBL) learning model and produce a student worksheet design that is feasible to be developed. This research can be continued in the implementation and evaluation stages.

2. Materials and Methods

This research is a descriptive study with a qualitative approach. The design development model used is the ADDIE (Analysis, Design, Develop, Implementation, and Evaluation) model. The ADDIE model design is the most well-known teaching model design because the stages are adjusted in detail [25]. Experts have stated another thing that the ADDIE model provides detailed specifications aimed at creating and measuring practical and

systematic learning [26]. The ADDIE design model consists of five stages, namely analysis, design, development, implementation, and evaluation. Each stage has its own learning goals so that students can achieve good results but there is a key, namely, students will spend time learning material independently with the flexibility to be more effective [27]. The purpose of this study is to design or design a product which in this study is teaching material in the form of student worksheets to improve creative thinking skills. In the analysis phase, researchers find out about the description of students' needs about teaching materials based on PBL learning models to improve the ability to think creatively. After that, researchers conducted observations and interviews with students and teachers to find out the learning model used by the teacher, teaching materials used by the teacher, student characteristics, material difficulties, and facilities in the school. The design phase, the learning objectives to be achieved are designed, a description of the learning activities to be carried out, the selection of media to be used, the learning design and a description of the tools for evaluating the assessment of learning in the meantime [28], [27]. At this stage, the researcher first makes the learning objectives to be achieved. The design phase in this study was carried out through the framework of the preparation of teaching materials. The experts will validate the product in the form of teaching material design. Design validation is carried out to determine the assessment as a revision material so that the model for developing good quality teaching materials. The subjects in this study were class XII MAN REO in Nusa Tenggara Timur. Data collection instruments include guidelines for observation and interviews. The design of the ADDIE model can be seen in Figure 1. This research is limited to the analysis and design stages.

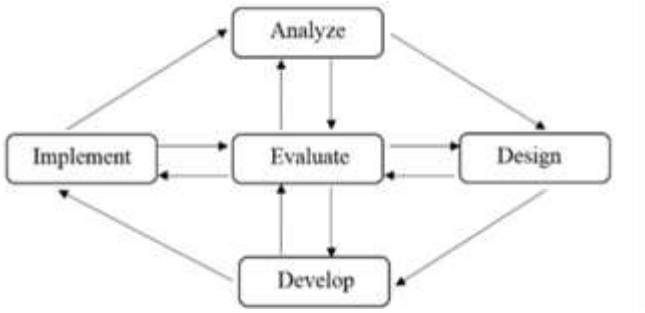

Figure 1. ADDIE Model Design [29]

3. Results and Discussion

3.1. Analysis

This stage contains an analysis of student needs. The need for teaching materials in the form of student worksheets to improve students 'creative thinking abilities, analyze students' character, teaching materials and learning models used by teachers, how to deliver materials and materials that are difficult for students to feel, school facilities and analyze solutions alternative to improve students' creative thinking skills. At this stage there are several conclusions, namely: (1) Students need teaching materials that can improve students' creative thinking abilities, (2) Participants have difficulty with material opportunities, (3) Teachers still use lecture and discussion methods, (4) Facilities in schools less complete, and (5) Alternative solutions to improve creative thinking skills is to design teaching materials with good learning models.

3.2. Design

At the design stage, the design of teaching materials is based on the results of needs analysis. The authors will design a link between the syntax of PBL and student worksheet so that it relates to the indicators of students' creative thinking abilities. The link is shown in Figure 2.

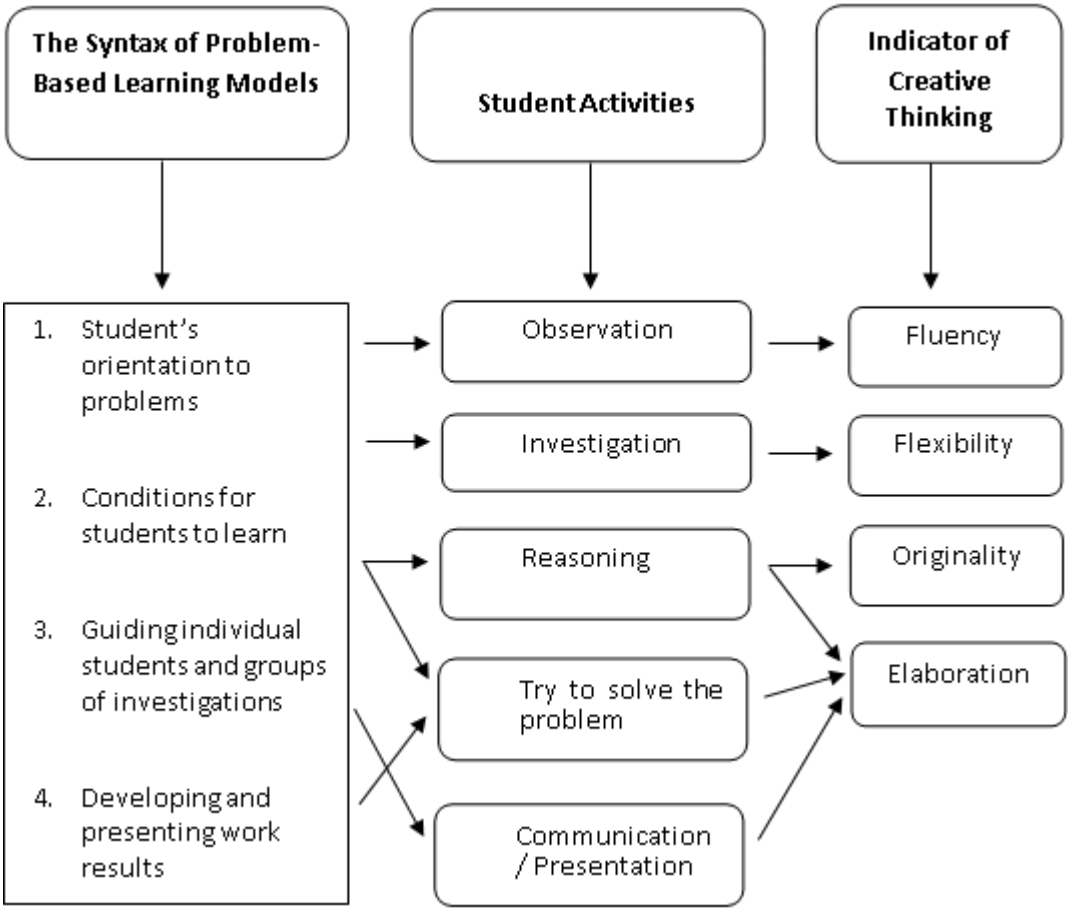

Figure 2. The relation of the syntax of Problem-Based Learning and student activities in student worksheet to the indicators of creative thinking

Based on Figure 2, namely: (1) Student's orientation to problems, presenting student Activities namely observing a problem that is being displayed by the teacher, where this is to increase student fluency, (2) Contribution for students to learn, here students will be directed to ask the teacher and the group friends and then this will be the subject of group discussion by students to bring flexibility, (3) Guiding individual students and groups of investigations, in this syntax students will be directed to reasoning and try to solve the problems in order to improve originality and elaboration, (4) Developing and presenting work results, then in this syntax students are asked to present the results of their respective group work which in order to improve elaboration, (5) Analysis and evaluation of the problem-solving process is the last syntax in which the student activity to try again to work on the problem evaluation given by the teacher to improve elaboration. Student worksheet contains cover, preface, table of contents, introduction, core competence, basic competence, indicators, Student worksheet user instructions, an order of use of student worksheet, concept map, student activities, evaluation, and bibliography. Figure 3 contains the title of the student worksheet that also includes classes and semester that students will use.

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Figure 3. Cover

The preface contains the author's thanks to the parties involved and the table of contents contains the sequence on the student worksheet and the page on the student worksheet. The preface and table of contents can be seen in Figure 4.

Figure 4. Preface and Table of Contents

Basic competencies and indicators contain what students must achieve when learning to use the student worksheet. Basic competencies and indicators can be seen in Figure 5.

Figure 5. Basic Competencies and Indicators

Furthermore, the concept map contains an outline of the mapping of material to students that aims to facilitate students to see the mapping to be learned. The concept map of the student worksheet can be seen in Figure 6.

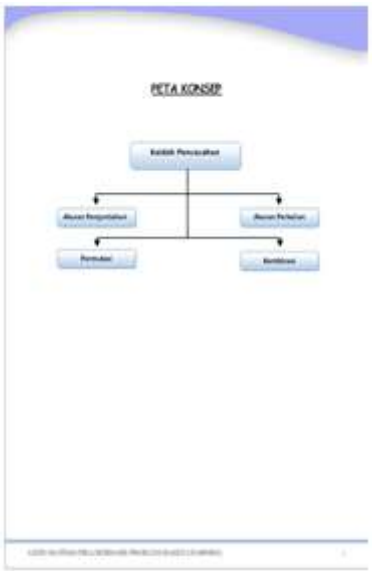


Figure 6. Concept Map

Student activities contain material and sample questions. The material is described so that students can understand the material. Examples of problems are given according to the PBL steps. Learning activities can be seen in Figure 7.

Figure 7. Student Activities

Evaluations are presented in the form of essays. The aim is to evaluate the learning outcomes of students in understanding the material that has been learned. Evaluation can be seen in Figure 8.

Figure 8. Evaluation

The teaching material in the form of student worksheets has been assessed for eligibility by

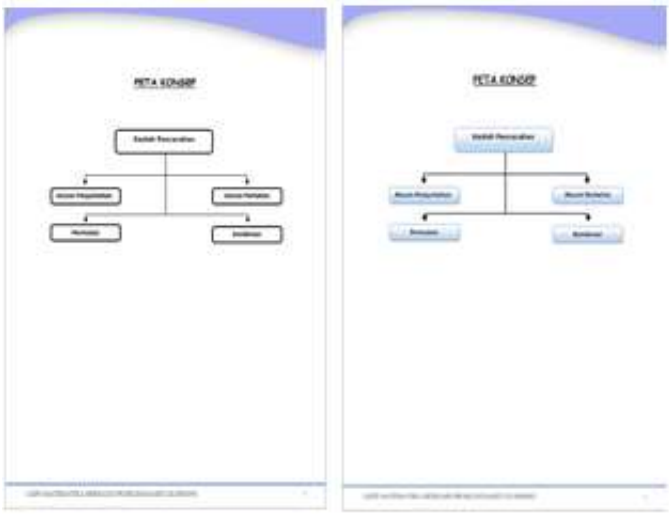
two mathematics teachers with a revision. Some input and suggestions from material and media experts that have been summarized can be seen in Table 1.

Table 1: Enter and Recommend from Validator

No.	Suggestions and Comments	Repair
1	Add a description to the introduction to make it easier for others to read	Already added
2	The concept map chart is not very interesting	Already repaired
3	Add learning objectives to students' activities	Already added
4	Expand evaluation questions	Already repaired

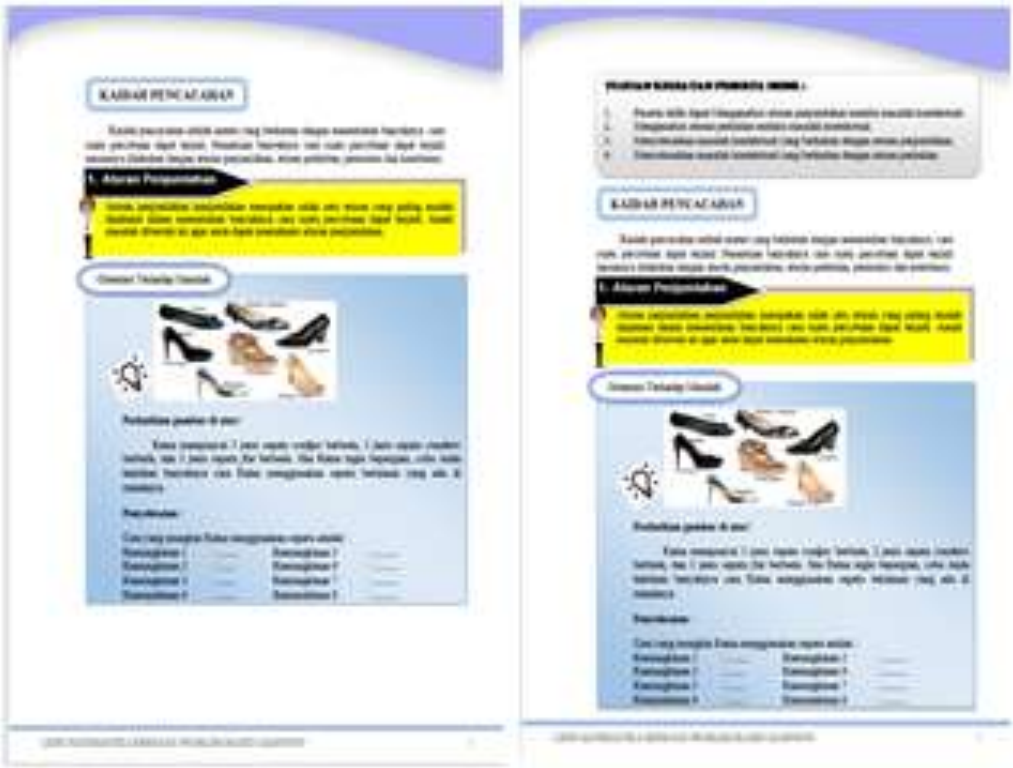
Comments and suggestions from the validators are then corrected according to the revisions given by the validators as shown in Figures 9-12 as follows.

Figure 9. Description after adding



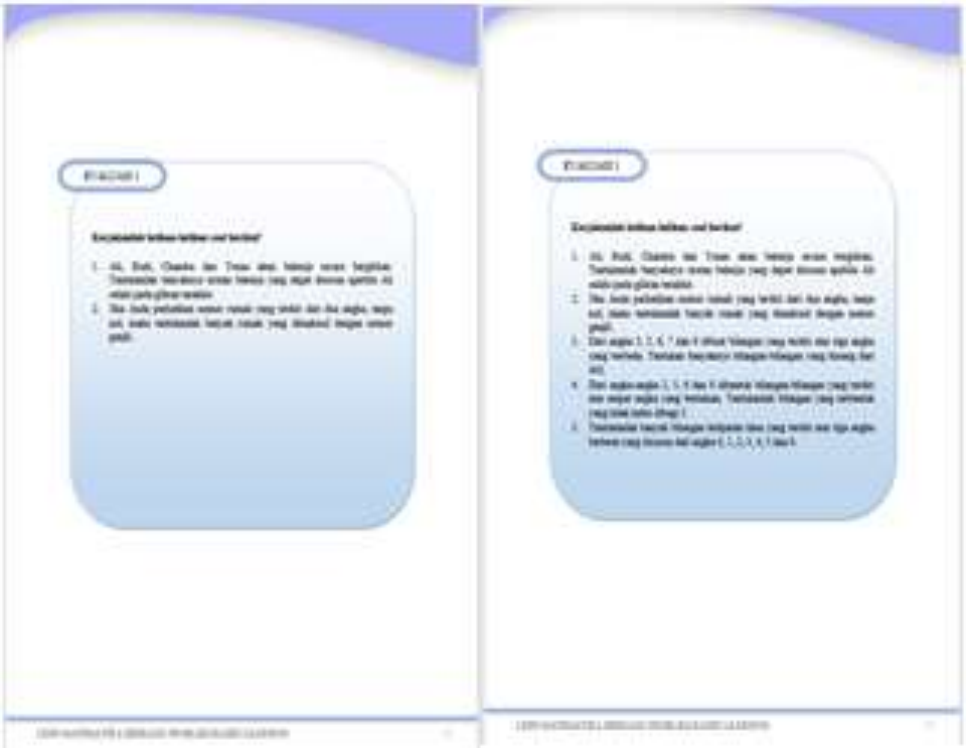
Before **After**

Figure 10. Chart of Concept Maps Before and After



Before **After**

Figure 11. Learning objectives before and after



Before **After**

Figure 12. Evaluation Questions before and after

Table 2: Design Assessment Results

No.	Validator	Score	Category
1	Siti Rahmah	93	Good
2	Erniyanti	78	Good
	Total Score	171	
	Average Score	85,5	Good

Based on Table 2, the average score for media expert judgment is 85.5. So it can be concluded that the learning media are in a good category. Learner worksheets have been validated by the validator and declared eligible with revisions. Revision of the student worksheet has been done. The next step is to increase the student worksheet.

The fourth step in the ADDIE stage is implementation. At this stage, products that have been developed and meet the eligibility and effectiveness criteria are given to the school that will be used as a place of research. This stage is carried out to ensure students achieve their goals in learning outcomes and can improve students' creative thinking abilities. The fifth step in the ADDIE stage is evaluation. At this stage, a process to provide value to the learning program that has been developed. Students will be evaluated to the extent to which students can learn the material so that it can improve students' creative thinking abilities. For the development, implementation, and evaluation phase is further research.

4. Conclusion

From the results of the above explanation it can be concluded that: (1) Students have difficulty learning material opportunities, (2) Students 'creative thinking skills are classified as low, (3) PBL learning models can be used to improve students' creative thinking skills, (4) learning resources that fit the Problem-Based Learning (PBL) model are not yet available, (5) Learning resources that instill creative thinking skills are not yet available, (6) The ADDIE development model is used to produce a student worksheet design that fits the Problem-Based Learning (PBL) learning model and integrates the students' creative thinking skills. This research will produce a teaching material design in the form of a student worksheet based on PBL learning models to improve the creative thinking skills of students who follow the curriculum and characteristics of students. The design of this teaching material consists of a cover, preface, table of contents, introduction, core competence, basic competence, indicators, student worksheet user instructions, an order of use of student worksheets, concept maps, student activities, evaluations, and bibliography. The design of the results of this study has the potential to enhance students' creative thinking skills for material opportunities. Based on the results of the validation it can be concluded that the design of teaching materials in the form of student worksheets is said to be appropriate to be used as a guideline in making teaching material on opportunity material with a PBL based model

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