Mathematics Module Development Design Based On PBL To Improve Mathematics Problem-Solving Ability

Annisa Sulistyaningsih, Suparman, Ellya Rakhmawati

Abstract: Problem-solving ability must be owned by each student in accordance to 21st century education. This ability is expected to improve student reasoning pattern strategy to deal with actual mathematics model problem. Problem based learning may improve the ability through sufficient learning material in the form of mathematics module. This research produces certain product in the form of mathematics module based on PBL model to improve problem-solving ability. This ADDIE research development took seventh graders of 09 Public JHS Yogyakarta. Stage in this study is researchers designed a prototype. Results 1 tested prototype one-to-one, parallel to the expert review stage, as the basis for revision to improve and produce a prototype 2. Prototype 2 was tested in the small group as a basis for revision to improve and produce prototypes 3. The results of this study are prototypes 2 which are ready to be used at the small group stage. Module design development through the analysis phase and design phase. The module is designed as interesting and easy to understand by students.

Index Terms: Ability, Design, Development, Improve, Mathematics Module, PBL, Problem-solving.

1 INTRODUCTION

MATHEMATICS is an accurate, logic, and systematic study to develop scientific situation, conclusion, and solution [1]. Its relevancy to 2013 curriculum aims to improve problem-solving ability for students through reasoning and communicating ideas. Furthermore, learning at school demands students to implement the ability in daily problems of mathematics models [2]. NCTM reveals mathematics purposes are to develop and gain comprehensive understandings of mathematics concepts and correlation while creating, comparing, and using various representations. To understand mathematics and represent it are an integral part of mathematics problem-solving [3]. The purpose to learn various mathematical concepts is to promote problem-solving which may be done by developing mathematics ability such as mathematics understanding and representation [4]. Four categories about the importance of problem-solving for a learning: a) common – dealing the development of cognitive problem-solving ability, b) dealing with development of problem-solving ability creatively, c) being part of the ability implementation process, and d) motivating students through the ability [5]. It is in line with Bell arguing that problem-solving phase occurs within highest level of thought among eight types of learning – learning signal, learning stimulus – response, learning orders, learning verbal association, learning discrimination, learning concept, learning rules, and learning problem-solving [6]. Polya stated that "Problem-solving is a teachable and learnable ability" among other steps: understanding problem, designing plan (developing plan), promoting the plan, rechecking (backtracking) [7]. The fourth step of problem-solving is intuitive but Polya' argued educators had chance to direct students thinking through natural process [8]. Problem-solving mathematics is important because main purpose of learning mathematics – the essence of learning it – is mathematics process which is prioritized and purpose to allow mathematics reasoning development [9]. 21st century is indicated by science and technology development which must be entailed by supportive learning to demand and global challenge of the era [10]. 21st century learning is expected to create trained human resources with 21st century ability [11]. Problem-solving ability becomes the important ability in learning to solve problems and implement it in actual mathematics modeled life [12]. Indonesia is one of the countries participating in PISA showing the percentage of problem-solving ability is level 1 as many as 49.7% students and level 2 as much as 25.9% students
[13]. TIMSS showed in 1999, 2003, and 2007, mathematics achievement scores of 8 graders in Indonesia were 403, 412, and 405. Meanwhile, in 2011, it was 386, under average scale of the students. Score 500 points could be grabbed in 2011 which represented 38th rank of 45 participating countries [14].. Beside problem-solving ability, other things to consider in teaching and learning material is to be selective and relevant to desired learning process goal, especially in improving mathematics ability, mathematics conceptual understanding, and learning independency [15]. Learning material functions a set of supportive source for both teacher and student activities in learning [16]. Indirect teaching methods and indescribable as distance learning (independent) suggested by Peters are: correspondence education, printed learning material, audio visual education, TV and radio education, programmed learning, training based computer, independent study, special learning, and learning through handbook [17]. Mathematics handbook used in independent learning is called mathematics

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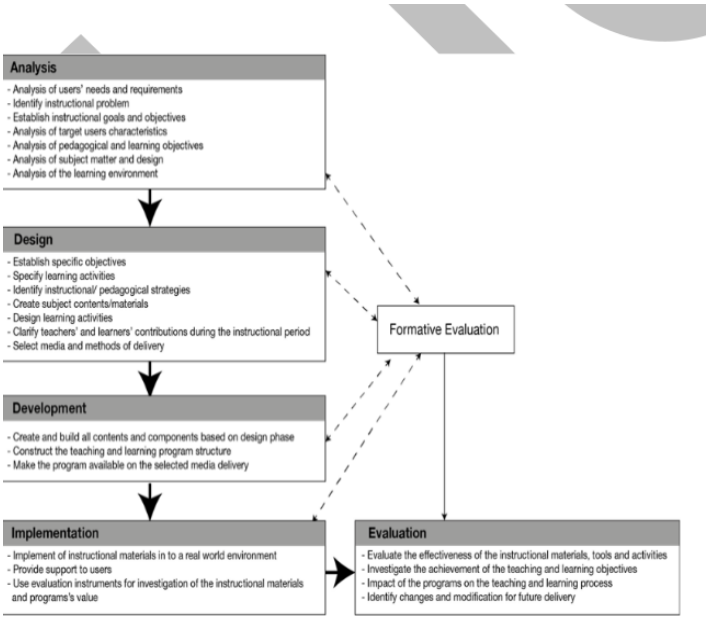
module.

This module facilitates students independently since it consist of complete and understandable explanation and is developed based on student characteristics [18]. One of successfully developed learning model to improve problem-solving ability is problem based learning (PBL). PBL is a learning approach using new edition to expose students into actual and applicative problems at working place [19]. PBL has been recognized since John Dewey whom argued about learning centered model. It is learning by involving students solving problem through actual life and correlation between stimulus and respondents [20]. PBL is collective the strategy which help each other to develop knowledge, comprehensive understanding, and generic ability such as collaboration, leadership, ability, motivation, and communication [21]. PBL provides students actual world problem to solve [22]. Even, module based PBL may improve problem-solving ability. Thus, the authors propose the development of mathematics learning problem based PBL to improve problem-solving ability using Polya stages.

2 RESEARCH METHOD

The subjects were seventh graders of 09 Public JHS Yogyakarta. This research and development referred to Analysis, Design, Development, Implementation, and Evaluation – ADDIE. ADDIE is the most frequent model on instructional design guideline to produce effective design. It helps instructional designer, content developer, or teacher to create and design effective and efficient teaching by implementing ADDIE process on each instructional product. ADDIE has systematic process and consists of important components in production process of instructional design which is always related one phase to another [23].As its abbreviation, ADDIE is systematic, dynamic, and flexible guideline to develop effective teaching with different activity within various ADDIE stages as shown in Figure 1 [24].

Figure 1. *Activities in Various ADDIE Stages*



However, this research is limited in two stages: analysis and design. Analysis phase was done in three parts: curriculum, material, and student characteristic analysis. The results were then used as the basics to develop the module as the products. The design in this research was started by composing framework and reviewing layout prototype design. The third step was developing and continued by fourth step – application the produced product. The fifth step was evaluation to judge product completely after being created and implemented. Instruments of collecting data were interview and questionnaire to determine reliability of product, observation and integrated interview. The type of the data is qualitative to analyze the implemented curriculum, the students' characteristics, and comprehensive material plus suggestion from experts. Quantitative data was reliability test score by subject expert and medium expert. Data analysis were Likert scale as measurement (collecting data by "weight measurement") while the items (item dots) consisting of ranged options. This research used 4 scale Likert since the subjects were limited. The, there was a need to look objective criteria of each question, to find interval score, and ranges by using this formula [25]. High Scores (X) : Number of Highest Score X Questions = n

: 5 X 4 = n

: n/n X 100% = 100%

Lowest Score : Number of Lowest Score X Questions

: 1X4 =4

: 4/20 X 100% = 20%

Range (R) : High Scores - Lowest Score

: 100% - 20%

: 80%

Category : 2

Interval : R/K = 80%/2 = 40 % Standart

Range : 100% - 40% = 60% Objective Criteria

The technique of analysis was qualitative by previewing and reducing all data to categorize, interpret, and present findings of the data.

3.DISCUSSION

3.1 Defining Stage

This research was conducted by designing mathematical learning modules based on Problem Based Learning for students of class VII SMPN 09 Yogyakarta. The following results module design development through the analysis phase and design phase of the ADDIE.

3.1.1 Analysis Phas

used by the students are in accordance with the core competencies, basic competencies, and indicators on the curriculum of 2013. The material described is in accordance with the indicators of achievement. On the use of the curriculum in 2013 focused on the learning process of students and teachers as a facility so that modules developed as a center Able to assist students in the learning process.

Materials analysis

In the analysis of material Obtained Algebra students experiencing Difficulties in understanding the material algebra, especially in modeling (transformation) for a given problem in the form of a story about a concrete or in the application of everyday life. Teachers in the provision of specific exercises relate to students lacking in everyday life, so students experience problems when faced with the question of the story. Teacher experience problems when applying the learning materials associated with real life.

Analysis of Student Characteristics

Analysis to identify the interest of students in mathematics includes a student, student activities in learning, Difficulties faced by students in understanding of teaching materials used in teaching mathematics. Based on the observation result the author has done in SMPN 09 Yogyakarta that student responses are less in Figure 2

Fig. 2: *Cover Front Display Module*

active. It is the caused by Several factors, among others: (1) The teacher was not linking the subject matter with real life, (2) Students are saturated in learning due to the lack of teaching materials that can support problem-solving ability, (3) Students do not understand the contents of the book curriculum in 2013, the which is given by the Department to support the teaching and learning process, and (4) Students are much-memorizing formulas but do not understand the concept.

3.2 Design stage

In the design phase, a module will be designed in the form of a module based mathematical learning Problem Based Learning. Based on the analysis above, the module-based learning Problem Based Learning math has been made as follows:

3.2.1 Part Opener

Cover

Cover module based learning Problem Based Learning mathematics is titled "Algebra Module for Junior Class VII", which means this module include algebra material for junior high school students of class VII. Giving the name of the title on the module to make it Easier to understand as well as on the cover of the author's name and origin are education writer. Following Cover display module design

Fig. 3: *Cover Final Display Module*

Title Page

Title page in math based learning module describes the Problem Based Learning module title, author module, supervising the writing module, the validator in the writing module and educational origin writer. Following the design of the title page view in Figure 4:

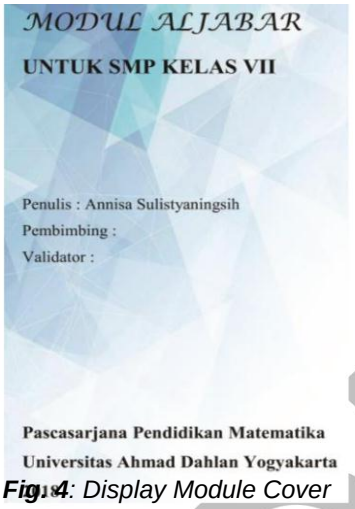


***Fig. 4**: Display Module Cover*

Foreword

The Foreword in the module based learning Problem Based Learning mathematics contains gratitude to God, reviews those who have helped in the making of this module and an apology as well as suggestions for module based math learning Problem Based Learning. The following Preface design view in Figure 5:

Fig. 5: Display Foreword

Table of Contents

Contents in the module-based learning are Problem-Based Learning mathematics Sub contains material to be covered in the module. Sub appeard the material based on the sequences present in the module. Facilitate the overall look of the Sub materials Discussed in the module as well as the listed page numbers to facilitate the reader in finding sub-material to be searched. The following table of contents design view in Figure 6:

***Fig. 6**: Display Contents*

Introduction

Introduction in mathematics learning modules based on Problem Based Learning contains descriptions of modules and module usage instructions. Description Module Explains in detail, but the brief content of the module, the purpose, and benefits of the module. Instructions for use module explain how to use the module properly. The following preliminary design view in Figure 7:

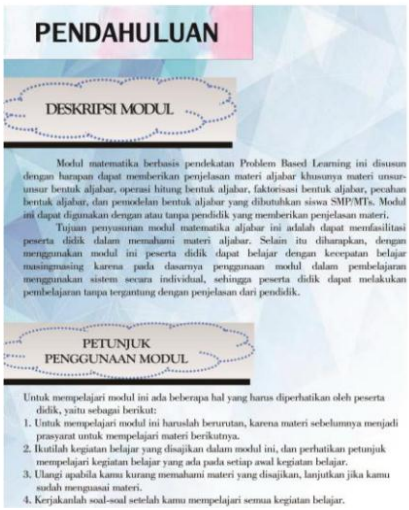


Fig. 7: Display Introduction

Figures Algebra

Algebra figures in mathematics learning modules based on Problem Based Learning is about historical figures that algebra students who know as well as Broaden his character and history. Here's what algebra figure design in Figure 8:

***Fig. 8**: Display Figures Algebra*

Concept Maps

Map of concepts in mathematics learning modules based on Problem Based Learning is about the conceptual framework of topics to be studied in the module and shows the relationship among the topics in the modules. Also concept map helps teachers to improve the effectiveness of the learning process in the classroom. Here's what a concept map design in Figure 9:

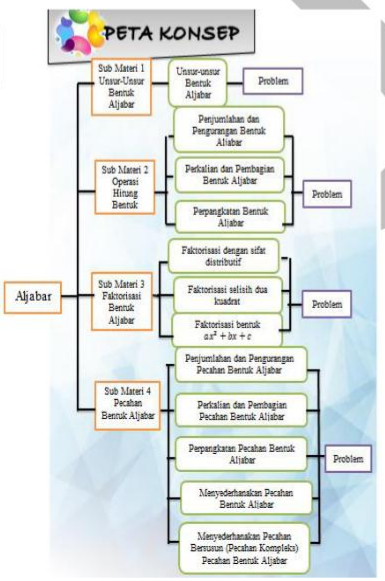


Fig. 9: View Folder Concept

3.2.2 Core Section

Component - based module components in Problem Based Learning, include: Presentation of the problem in the description of the material, the following display in Figure 10:

***Fig. 10**: Display Problems*

Organizing learning activities of students, following the appearance of the figure 11:

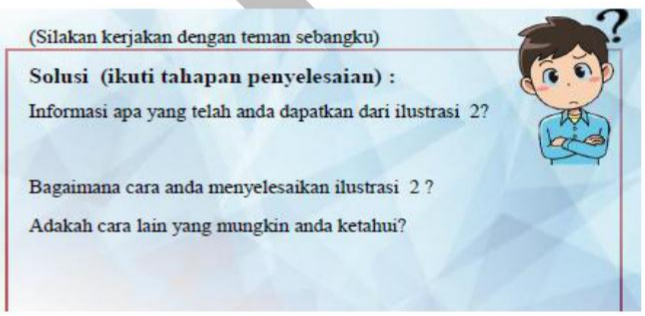


***Fig. 11:** Display Organize Group*

Guiding independent inquiry and groups, following the appearance of the figure 12:

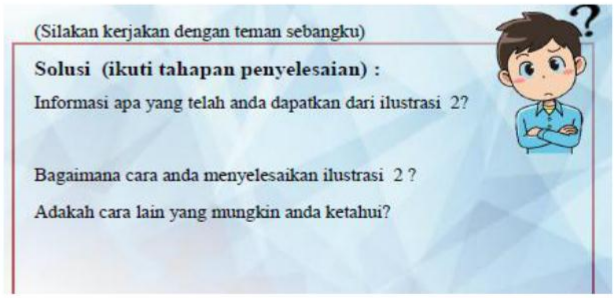


***Fig. 12:** Assist Investigations*

Presenting and develop the work, following the appearance of the Figure 13

:

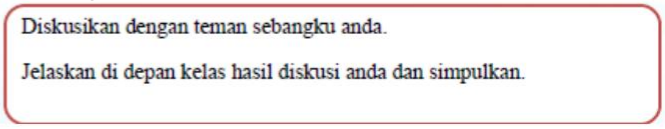


***Fig. 13:** Presenting and developing*

Exercise self-evaluation form, following the appearance of

the figure 14:

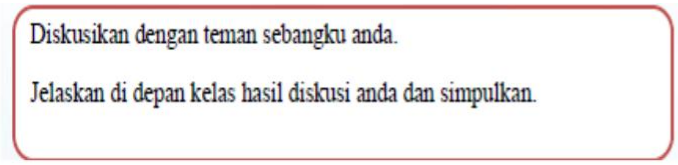


Fig. 14: *Exercise self*

3.
2.3 Section Cover
Competence test
Test competency in math-based learning modules Problem Based Learning This contains a set of practice exercises that support the students to practice in accordance with sub-material being discussed. Here's what a competency test design in Figure 15:

Fig. 15: *Competency Test*

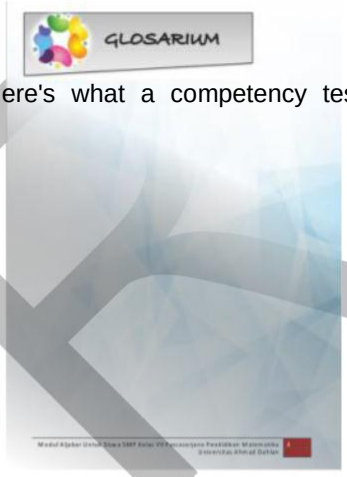


Fig. 17: *Glossary*

Fig. 16: References

Fig. 18: *Answer Key*

REFERENCES

References in the module-based learning with Problem Based Learning mathematics is unbiased sources of information about the contents of the module. The following bibliography at the design view image 16:

Glossary

Glossary in mathematics learning modules based on Problem Based Learning contains definitions of concepts that are discussed in the module. Those definitions are summarized in order to facilitate students in the recall concept that had studied. The following glossary design view in Figure 17:

Answer key

Zuhri, S.Pd., M.Pd as professor of Mathematics Education University of PGRI Semarang, Eka Febianjani Putri, S.Pd as teacher of mathematics school, and Noor Haryati Wulandari , S.Pd as teacher of mathematics. Category rating criteria idea by Likert seen from the table 1:

Table 1 *Category Rating Criteria Idea*

Score range	Calculation	Classification
If the percentage of total respondents answers has a value > 62,5%		GOOD
f the percentage of total respondent's answers has a value of < 62.5%		NOT GOOD

From the calculations in table 1, it was obtained $60\% < X$ is GOOD but $X < 60\%$ is NOT GOOD. The validators provide comments and suggestions to support the perfection in making module designs seen from table 2:

Table 2 Comments and suggestions from Experts

No.	Expert	Comments and suggestions
1	Heni Purwati,M.Pd	Must be consistent between the table of contents and contents KD should fit Permendikbud and customized indicators More about the story
2	Muhammad Saifuddin	Modules arranged in modules do not match the indicators

The answers on math learning modules based on the Problem Based Learning contains of the answer key of exercises so that students can see the steps and results of the work about. Here's what the answers on the image design 18 Evaluation of design, at this stage in the prototype design of Module 1 was evaluated using formative evaluation developed by Tessemer. Stages in the evaluation includes self-evaluation, expert reviews and one-to-one. In the first self-evaluation. At stage, the first prototype of consistent lack of content with its contents and prologue to the story about the less comprehensible students. On prototype 1 in consultation with competent experts. Experts Heni Purwati, M.Pd as professor of Mathematics Education University of PGRI Semarang, Muhammad Saifuddin
:

	Zuhri,listed S.Pd.,M.Pd	Modules are in accordance with PBL steps
3	Febianjani Eka Putri., S.Pd	More about the story Giving the word "important information" on something that is considered important In less cover words "based"
4	Noor Haryatithat is easily understood Wulandari., S.Pd	Additions to about the story

Table 3 *Results Calculation Questionnaire Design validation module*

Respondent	Score	Calculation	CriteriaTo Quantitative Data
Heni Purwati,M.Pd	16	(16/20) 100% 80%	X = GOOD
Muhammad Saifuddin Zuhri, S.Pd.,M.Pd	19	(19/20) 100% 95%	X = GOOD
Febianjani Eka Putri.,S.Pd	17	(17/20) 100% 85%	X = GOOD
Noor Haryati Wulandari., S.Pd	19	(19/20) 100% 95%	X = GOOD

Not only comments and suggestions, the results of the questionnaire design validation module assessment given by the validator are calculated and classified like table 1 and get results as in table 3:

Based on table 3, the media expert assessment these results indicate that the design of teaching materials in the form of modules that will be developed in the excellent category. Based on the comments from experts contents of lecturers and teachers so that the first prototype was revised to prototype 2. Part of the revision can be seen in figure 19 below:

4 CONCLUSION

The final conclusion is that the development of PBL MODULE based learning model has been through all the stages in the preliminary study phase, which includes the analysis and design by ADDIE. Some stages of the Formative Evaluation phase that has passed is a self-evaluation, expert review and 1-1. The resulting product is a prototype 2. For the next stage, the prototype 2 will be used in a small group stage.

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