

Teaching Materials of Problem-Based Linear Equation System with Two-Variables for Eighth-Grade Students in Junior High School

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ABSTRACT

This research is motivated by the lack of mathematics teaching materials that can make students learn on their own. The teaching material can be created by teachers as they are the ones who possess the knowledge about their students' characteristics. Further, learning materials are a set of materials (information, tools, or texts) that can aid teachers and students to carry out the learning process. The two-variable linear equation system (SPLDV) is one of the mathematics materials taught to eighth-grade students of junior high school; it contains problems related to daily life. However, it is found that this material is still difficult to master by most students. Therefore, it is necessary to develop the SPLDV teaching materials that can help students learn and solve problems as well as be used as examples by teachers in developing other materials. This research aimed to make problem-based SPLDV teaching materials. The research method refers to the Four-D Model by Thiagarajan, Semmel, and Semmel (1974). It consisted of defining, designing, developing, and disseminating. The results showed that problem-based SPLDV teaching materials could be used in learning activities as the students and the teachers had shown their positive responses after going through expert assessments. This study also suggested that the teachers use this teaching material and adopt teaching materials for other similar materials.

1. Introduction

Mathematics is a subject that provides students with problem-solving skills. These skills are applicable in mathematical contexts and in daily life contexts. Simply put, students can benefit much from the logical and critical thinking processes that they learned from the subject. These thinking processes are incorporated into the teaching materials used by teachers and students.

Problem-based mathematics teaching materials for independent learning are yet to be used by many teachers. Such media can be designed by teachers, considering that they are the ones who understand the students' characteristics. Teaching materials are described as all materials or media that help teachers or instructors in classroom teaching and learning activities (Amri, Ahmadi, & Haryanto, 2010; Prastowo, 2011). The media take many forms, ranging from information, materials, and texts that are required for educators in the planning and researching learning implementation (Polya, 1973). Teaching materials are defined as all materials or media that help teachers or instructors in classroom teaching and learning activities. The media involve written or unwritten media (Depdiknas, 2008). Further, teaching materials encompass the materials, information, learning kits, and texts for helping teachers and students during the learning process (Abbas & Zakaria, 2018).

Several types of teaching materials include: (a) visual media, such as handouts, textbooks, modules, student worksheets, brochures, leaflets, wall charts, photos, pictures, and even non-printed media, e.g., model or mockup; (b) audio media, namely cassettes, radio, vinyl records, and audio CD; (c) audio-visual media, e.g., VCD and movies, and; (e) interactive multimedia, namely CAI, multimedia CD for interactive learning, and web-based teaching materials.

One example of mathematics learning material for the eighth graders (junior high level and its Islamic school equivalence or MTs) is two-variable linear equations (Pannen & Purwanto, 2005). On that ground, developing problem-based teaching materials for

teaching the two-variable linear equation system is deemed essential. The media cover four steps in solving the problems related to the material. Those steps are: (1) understanding the problem, (2) devising a plan, (3) carrying out the plan, and (4) looking back (Menteri Pendidikan dan Kebudayaan Republik Indonesia, 2016). In mathematics learning, four steps of solving a problem involve: (1) understanding problems, i.e., identifying the problem and checking data sufficiency; (2) designing problem-solving plans, i.e., developing a mathematical model based on a given problem; (3) executing problem-solving plans by selecting and applying problem-solving strategies, and; (4) rechecking the results (Offirstson, 2014). Considering the above discussion, the teaching materials covering all of the above problem-solving steps would be visual media (books). The main components that should be incorporated in all teaching materials are the overview of the lesson, introduction, main discussions and concluding parts of each chapter, references, and lists of abbreviations (Pannen, & Purwanto, 2005). The systematics of the developed media are the results of modifying ideas (Pannen & Purwanto, 2005).

2. Methodology

The present work was conducted in the Department of Mathematics Education and SMP 6 State Junior High School in Gorontalo City. This study employed a development design. Steps in developing the problem-based teaching materials involve defining, designing, developing, and disseminating (Rahayu, 2009). The present study ended in the development step. Processes in the defining step encompassed the preliminary and final analysis, material analysis, indicator of competence achievement, and learning goals. In the designing step, the format of the teaching materials was developed. Following the previous step was the development step, which focused on a limited trial through empirical and expert validations; it intended to gain information regarding teachers' and students' responses.

Non-test methods were employed to collect the data; the instrument involved a spreadsheet used to retrieve expert validations results. After retrieving the results of the validations, a limited trial was performed to get information on teachers' and students' responses regarding the use of problem-based media in learning. The assessment instrument for collecting the responses was a checklist form.

The present work applied a descriptive analysis to categorize the teachers' and students' responses using a percentage. Further, a qualitative analysis was performed to interpret all inputs from the experts, as stated in the spreadsheet.

3. Results and Discussion

3.1. Define Stage

Within this step was an analysis of the 2013 Curriculum, specifically the core and basic competence (Depdiknas, 2008). The basic competence related to the knowledge and skills is provided in Table 1.

Table 1. Basic Competence of Knowledge and Skills

| Basic Competence | | Basic Competence | |
|------------------|---|------------------|--|
| 3.5 | Explaining the two-variable linear equation system and it's problem-solving linked with a contextual problem. | 4.5 | Solving a problem related to the two-variable linear equation systems problem-solving Skills, Two Variables Linear Equation System |

Based on the discussion with mathematics teachers of several state junior high schools, viz., SMPN 1 Suwawa, SMPN 2 in Gorontalo Regency, SMPN 3 in Gorontalo City, and SMPN 6 in Gorontalo City, the total contact hours for the learning activities focusing on the two basic competence is 15 hours and 18 hours, excluding evaluations on several sub-lessons, namely elimination method, substitution method, and graphical method. Each of the sub-lesson contains concepts and problem-solving tips. All in all, the teaching materials for the topic of two-variable linear equation systems discuss several problem-solving methods, namely elimination, substitution, a combination of elimination and substitution, and graphical.

The analysis result of basic competence and subtopics obtained the formulation of competence achievement indicators and learning objectives, as presented in Table 2.

Table 2. The Formulation of Competence Achievement Indicators and Learning Objectives

| Competence Achievement Indicators | | Learning Objectives |
|-----------------------------------|--|---|
| 3.1.1 | Calculate the variable value of the two-variable linear equation system using elimination, substitution, the combination of elimination and substitution, and graphical method | <ol style="list-style-type: none"> 1. Properly calculate the value of a variable in the two-variable linear equation system using the elimination method. 2. Properly calculate the value of a variable in the two-variable linear equation system using the substitution method. 3. Properly calculate the value of a variable in the two-variable linear equation system using the combined elimination and substitution method. 4. Properly calculate the value of a variable in the two-variable linear equation system using the graphical method. |
| 4.5.1 | Solve the problem of the two-variable linear equation system using elimination, substitution, the combination of elimination and substitution, and graphical method. | <ol style="list-style-type: none"> 1. Properly solve the problem of the two-variable linear equation system using the elimination method. 2. Resolve the problem of the two-variable linear equation system using the substitution method. 3. Resolve the problem of the two-variable linear equation system using the combined method of elimination and substitution. 4. Resolve the problem of the two-variable linear equation system using the graphical method. |

3.2. Design Stage

The teaching materials format was compiled in chapters consisting of an introduction, contents, and concluding part. The design result is as follows: The first chapter was comprised of a short description, basic competence, competence achievement indicators, and a draft. The contents chapter contained a short description of the topic, learning objectives, and the topic presentation (encompassing the overview, summary, and exercise section). The concluding part contained formative evaluations, references, and lists of abbreviations. The teaching materials early draft are as follows:

| | |
|-------------|---|
| Chapter I | Introduction |
| Chapter II | Elimination method and problem-solving |
| Chapter III | Substitution method and problem-solving |
| Chapter IV | Combined method of elimination-substitution and problem solving |
| Chapter V | Graphical method and problem solving |
| Chapter VI | Concluding part |

3.3. Design Stage

3.3.1. Experts Validation Results

Seven experts have validated the teaching materials. Three junior high school mathematics teachers and two mathematics lecturers validated the teaching materials based on the mathematical content, while one lecturer validated the language, and another one validated the layout. The overall results of expert validation for mathematics content and learning received good feedback. However, it is recommended to provide more problems and problem-solving guidance. The validation results in terms of language and layout were considered good. Still, there were some sentences requiring corrections.

3.3.2. Field Test Results

The field tests were performed to obtain information regarding the readability of the teaching materials as a result of expert validation, which was held in a small class obtained from the response of students and teachers in two meetings.

3.3.3. Students' Response Analysis Results

Students' responses to the teaching process with problem-based teaching materials are provided in Table 3.

Table 3. Students' Average Response in Learning

| No | Responses | Percentage (%) |
|--------------------|---|----------------|
| 1 | Pleased with the material delivery, classroom learning activities, teachers' method | 100 |
| 2 | New to the material delivery, classroom learning activities, teachers' method | 90.91 |
| 3 | "Helpful" teaching materials | 100 |
| 4 | "Comprehendable" contents of teaching materials. | 81.82 |
| 5 | Clear and comprehendable figures/graphics/illustrations. | 90.91 |
| 6 | Comprehendable language | 100 |
| 7 | Attractive layout of teaching material contents | 90.91 |
| Average percentage | | 93.51 |

Table 3 shows that the average overall assessment of students' responses regarding the problem-based learning model receives a very positive response (93.51%). These findings revealed that teaching with said materials resulted in a positive response; simply put, teachers can utilize the materials to help students in learning the topic inside or outside the class. Any form of materials can help teachers and instructors in the classroom learning process (Amri, Ahmadi, & Haryanto, 2010; Prastowo, 2011).

3.3.4. Teachers' Response Analysis Results

The teachers' responses to the teaching process with problem-based materials for the two-variable linear equation system consisted of the following aspects: (1) the helpfulness of the teaching materials in the learning process, (2) the novelty of the teaching materials, (3) the attractiveness of figures/graphics/illustrations, (4) other material worth developing (5) activities that need to be done (if requires development). The response assessment results of two mathematics teachers from SMP 6 state junior high school in Gorontalo indicated that the teaching materials were problem-based and were considered helpful in the learning activities. The teaching materials were new; the figures/graphics/illustrations were attractive; the problem-based teaching materials need to be developed for other materials and require training. This means that teachers also provide a positive response to the developed materials.

Based on the results of validation experts and the limited trial in small groups on the implementation of problem-based teaching materials, highly positive responses were obtained from students and teachers.

4. Conclusion

This research aimed to make problem-based SPLDV teaching materials. Based on the findings and discussion, it can be concluded that the problem-based teaching materials for discussing the topic of two-variable linear equation systems are considered feasible to be used as one of the alternative learning examples for eight grade students. This study could be literature for teachers using SPLDV teaching materials in junior high school students. As this study is only limited to junior high schools students, the materials deserve follow-up in other research to identify the good qualities of the teaching materials.

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