The Development Of Problem-Based Mathematics Learning Model For The First Year Vocational High School Students

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ABSTRACT

This study is intended to produce a problem-based mathematics learning model for SMK (Vocational High School). The development used the Plomp development model. The procedures are: (1) preliminary study; (2) the stage of developing or making a prototype; and (3) assessment phase. The feasibility of a problem-based mathematics learning model for SMK that is developed refers to the product quality criteria that are valid, practical, and effective. The development of problem-based mathematics learning models for Vocational Schools involved two experts and three practitioners. The objects in this study were students of first year vocational high schools in South Tangerang City and three mathematics teachers. Sampling techniques used in this study are purposive sampling, stratified random sampling, and proportional random sampling. The instruments used consist of: instruments for evaluating validity which included validation sheets, instruments for assessing practicality which included practicality assessment sheets from teachers and students, and observations sheets for the implementation of learning, as well as effectiveness assessment sheets namely learning achievement tests. The results showed that the learning model developed includes syntax, social systems, reaction principles, support systems, and learning impacts that meet valid, practical, and effective criteria.

Keywords: learning model, mathematics, Problem-Based Learning, Vocational High School

INTRODUCTION

Ministerial Decree of National Education No. 22/2006 concerning with national standards related to mathematics learning states that this mathematics is given to students with the intent and purpose to equip students with logical, analytical, systematic, critical, and creative thinking skills and have the ability to cooperate (Ministry of National Education, 2006: 387). So the concept of learning mathematics at the Vocational High School (SMK) should be able to facilitate students to think logically and critically and be able to develop creativity in solving problems and be able to communicate their ideas. The ability to think critically is determined by the quality of learning held in the classroom. Therefore, educators/teachers should be able to conduct learning effectively by selecting and developing learning models that are appropriate to the material and characteristics of students.

One meaningful learning model oriented towards students' critical thinking abilities and facilitates student involvement in learning is the problem-based learning model (PBLM). The learning model is suitable for vocational students because this type of vocational education specifically prepares graduates to be skilled and ready to enter the wider community. Through problem based learning

model (PBLM), students will actively participate in learning and can shape students into flexible and critical thinkers. Therefore, this study includes the development of problem-based mathematics learning models for SMK students. The development of this model is directed to improve students' critical thinking skills. Through this learning model, students are prepared to get used to solving problems that are directly related to daily life.

The results of the National Vocational High School (SMK) Exams in South Tangerang City show that mathematics has the lowest score among other subjects o and the majority of students have grades below 55. In addition, interviews with vocational students show that most students consider mathematics to be difficult and learning is still teacher-centered, namely: the learning model used since entering vocational high school has not been meaningful. It is still very rare for a number of studies to develop suitable learning models applied to all different subject matter, especially in mathematics.

Based on this background, this study will develop a problem-based mathematics learning model for Vocational Schools with the Plomp model. The procedures are: (1) preliminary study; (2) the stage of developing or making a prototype; and (3) assessment phase. The objects in this study were students of grade X vocational schools in South Tangerang City. Sampling techniques in this study used purposive sampling, stratified random sampling, and proportional random sampling. The type of data in this study consisted of quantitative and qualitative data. Quantitative data were obtained from expert and practitioner validation, observational data of learning implementation, student response data, learning achievement data and critical thinking skills data. While qualitative data was obtained from comments, suggestions, and revisions from experts on the validity and practicality of the product being developed as well as student comments on the implementation of learning by using problem-based models to improve the critical thinking skills of vocational students.

RESEARCH METHOD

This research is included in the type of research and development (R&D) or the type of research and development. The development in this study is in the form of a problem-based mathematics learning model for Vocational Schools equipped with supporting tools for implementing learning in the form of student worksheets (LKS).

The development model used in this study is the Plomp development model. Based on the results of a study of the Polmp model (2013: 19), the steps in the research and development that are used are: (1) Preliminary research (preliminary study). Needs and context analysis, literature review, developing conceptual and theoretical frameworks. (2) Development or prototyping phase (development / manufacture of prototypes). The design process of developing or making prototypes, conducting formative evaluations, and refining to perfect prototypes. (3) Assessment phase (assessment). Field trial, and ended the semi-summative evaluation to conclude whether the product met the specified criteria.

Product trials are conducted with the aim of getting empirical data and getting input as revised material. Empirical data is used to test whether the product developed meets valid, practical and effective criteria. Activities undertaken in the design of product trials are: (1) Test the instrument. The instrument used to measure effectiveness is a learning achievement test. This trial is to find out the reliability of the test, the power of difference, the level of difficulty and the effectiveness of the deception. (2) Testing the learning model. Initial products that have been declared valid and feasible by experts and practitioners are used as products that are tested in the field. (3) The first phase of field trials is used to determine the practicality and effectiveness of the application of the developed product. The trial results are analyzed and used as a basis for evaluating and improving products. If the analysis shows that the product is practical and effective, then the trial activity has ended and the product produced is the final product. However, if the results of the analysis show that the product is not yet practical and effective, then repairs are made and retried until a practical and effective product is obtained.

The subjects of this study are vocational students in the city of South Tangerang who have. So that the test subjects can represent the ability of vocational students in South Tangerang City, the sampling in this study uses stratified random sampling techniques, proportional random sampling techniques and purposive sampling techniques.

The data in this study were obtained by observation and test delivery. The data collection instruments used in this study include: (1) Validity assessment instruments. This validity assessment instrument was used to obtain an evaluation of the validity of the problem-based mathematics learning model for Vocational Schools. (2) Practical instruments. This practical instrument is used to obtain data about the implementation of learning and the practicality of using the problem-based mathematical learning model for SMKs that are developed. (3) The effectiveness instrument used in this study was a multiple choice test

The types of data in this study are quantitative and qualitative data. The steps taken to determine the quality of the learning model developed are: (1) Quantitative data in the form of expert and practitioner validation data, observational data of learning performance, teacher practicality assessment data and student response data obtained on a scale of five are converted into qualitative data using a reference formula adapted from Azwar (2015: 163). (2) Qualitative data in the form of comments and suggestions that are analyzed qualitatively are then used as materials for improvement of the learning model products developed. Before field trials are conducted, the instrument feasibility tests are conducted and then analyzed in the form of instrument validity and instrument reliability. Validity is used to know tests of learning achievement and critical thinking skills obtained by asking the opinions of 3 experts and 3 practitioners. The test instrument is suitable for use if all items are declared valid and the general conclusions must be in a category suitable for revision or appropriate for use. While the reliability estimation uses the Cronbach's alpha formula. The reliability

coefficient is used to calculate the standard error measurement (SEM) with the help of iteman software version 3.00.

RESULTS AND DISCUSSION

The problem based mathematics learning model for Vocational Schools produced in this study includes: syntax, social system, reaction principle, support system and learning impact. The learning syntax is designed to give students the opportunity to construct their knowledge. The syntax of problem-based mathematics learning produced is as follows.

Table 1. Syntax of Problem-Based Learning

No	Syntax	Students' Activities
1.	Presentation of the problem	- observing the problem - asking questions that are not yet clear
2.	Organizing students for learning	- working together in groups - understanding socio-cultural values to interact with teachers and friends.
3.	Identification and formulation of problems	- analyzing information - formulating the problem - identifying additional information
4.	Investigation and problem solving	- gathering information from various sources - making assumptions - making a pattern - making ideas to solve problems - evaluating the results obtained
5.	Presentation of results	- describing or communicating the results obtained - comparing group answers with other groups
6.	Rating and conclusion drawing	- evaluating the results of all groups - interpreting the solution obtained - making conclusions

Based on Table 1. The syntax of problem-based mathematics learning includes 6 steps. The first step which is an initial learning activity is the presentation of problems. The activity begins with the teacher delivering, the learning objectives, and learning motivation. Motivation conveyed by the teacher contains the benefits obtained by students in their daily lives after studying the material accompanied by encouragement to be actively involved in learning activities. Then the teacher presents a problem in the form of a picture or narration. In addition, the teacher can also provide extras by displaying relevant videos through the projector.

The second step is organizing students to learn. In this step the teacher forms students into study groups consisting of 4-5 students per group. Teachers need to pay attention to several aspects in forming groups so that learning groups that are formed are heterogeneous. In addition, teachers also need to provide understanding and motivation to students about the importance of openness and

acceptance of other people in a heterogeneous group so that students are able to learn to work with anyone their colleagues. Furthermore, when students are able to show their acceptance attitude, the teacher then explains how to work well with colleagues and the teacher in solving problems.

The third step is the identification and formulation of the problem. In this step, the teacher asks students to identify problems in the form of important information presented. This activity is carried out individually so that students are able to understand the problems that will be solved during the learning process. After that, students in groups conduct discussions to formulate problems and determine additional information that must be known. The task of the teacher in this step is to facilitate students during the identification and problem formulation process by providing instructions, questions or assistance to students. The activity in this step aims to practice students' analytical skills in identifying relevant information according to the problem given.

The fourth step is investigation and problem solving. In this step, students conduct an investigation by choosing a strategy that will be used to solve the problem. This step aims to practice the ability of students to plan procedures and choose the right strategy to solve the problem. The teacher asks students as a group to determine the right strategy to solve the given problem. The chosen settlement strategy is then used as a solution to resolve the problem presented. In this step the students' ability to create ideas, make guesses, make patterns or modify the concepts they have is trained to suit the context being faced. In addition, students are also trained to evaluate the processes and results obtained before making conclusions. In this step the teacher also provides facilities by providing assistance, questions and instructions to students in order to solve problems. The purpose of the teacher giving questions to students is to lure students to think more deeply. The results of the investigation at this stage are written in groups to be presented.

The fifth step is the presentation of results. The purpose of this step is to train students' communication skills in conveying ideas/ideas to others. Some of the designated groups have the task of presenting the results of problem solving in front of the class. The appointment of the group is based on the uniqueness of the results of the investigation, among others: answers other than other groups, answers need emphasis or creative answers. This activity begins with the teacher designating one of the groups to present the results then the teacher gives the other group the opportunity to provide responses or questions. Occasionally the teacher also asks questions to ascertain the extent of student understanding.

The final step in this study is the assessment and withdrawal of conclusions. In this step, the teacher is tasked with directing students to review the results of problem solving that have been done. After that, the teacher together with students draw conclusions and provide reinforcement of the concepts contained in the investigation activities that have been carried out by students. Furthermore, the teacher tests students' understanding by giving several examples and not examples related to the concept of the material being taught. This activity

aims to determine the effectiveness of the problems given to students, the quality of the work, and efforts to monitor student learning success.

Social systems created in problem-based learning include: (1) students are active in learning and active teachers become facilitators of learning. (2) students solve problems both individually and in groups and the teacher is tasked with encouraging conducive interactions. (3) students are free to be creative in determining the problem solving strategies that are used and the teacher directs and provides instructions for solving the problem so as not to spread too broadly.

The social system of problem-based learning process is supported by cooperative learning models. Through cooperative learning, students can work together to solve problems in groups. Students are free to discuss, dialogue, submit opinions or questions and even debate according to the theme of the problem given. The teacher's role here is as a facilitator whose role is to facilitate student activities in problem solving. Teachers are not allowed to dominate students too much, only to facilitate or provide adequate assistance to students until finally they are able to solve the problem. Thus this learning is also included in guided discovery

The problem-based learning model support system that was developed is the model book equipped with an explanation of problem-based learning, learning steps, a brief description of the material, student worksheets and practice questions.

The principle of reaction in the problem-based learning model is that the teacher acts as a facilitator, motivator, mediator and evaluator in learning. The teacher's role is to direct and emphasize the problem solving process, as well as provide feedback on students' mathematical solutions. The teacher also has the duty to give students the opportunity to express ideas openly, observe student understanding and lure students to find solutions to the problems given. In addition, teachers also provide opportunities for students to issue responses or questions to other groups. The teacher acts as a mediator that bridges students and closes the gap between students. The teacher must be neutral and not take sides with any group or any individual so that it can create a conducive and pleasant atmosphere in learning. In addition, the teacher is also tasked with overseeing the course of the discussion so that it does not extend too far from the subject and is able to relate to conditions in the real world.

Furthermore, the principle of the teacher's reaction when explaining is to draw the attention of students to pay attention to the explanation delivered. Therefore the teacher must prepare various methods that are able to attract students' attention from the preliminary, core and closing activities.

Based on the results of expert and practitioner assessments of the problem-based mathematics learning model for Vocational Schools for Vocational Schools, the average score of validity is 99.17 which means that it has good criteria. Furthermore, the practicality assessment given by the three teachers averaged an assessment score of 82 with practical criteria. Meanwhile, the average score of practicality assessment of students was 55.28 with practical criteria. Analysis of the effectiveness of the problem-based learning model is determined by the

completeness of student learning. The impact on achieving student learning success is shown to be at least 75% of the number of students reaching the KKM (Minimum Requirement Standard) value of 70. Based on the data on student achievement test results, the results obtained that the number of students from the three trial classes that reach KKM (completion) has exceeded 75% so that the model mathematics learning that is developed effectively is viewed from the completeness of student learning.

CONCLUSION AND SUGGESTION

Based on the results of the assessment and field trials it was concluded that the problem-based mathematics learning model for SMK (Vocational High School) had met the eligibility criteria (valid, practical and effective). The syntax of the problem-based mathematics learning model for for SMK is the presentation of problems; organizing students to study; problem identification and formulation; investigation and problem solving; presentation of results; and assessment and conclusion drawing.

Social systems created in problem-based learning include: active students in learning and active teachers becoming learning facilitators; students solve problems individually and in groups and the teacher is tasked with encouraging conducive interactions; and students are free to be creative in determining the problem solving strategies that are used and the teacher directs and provides instructions for solving the problem so that it does not widen too broadly. While the principle of reaction in the problem-based learning model is that the teacher acts as a facilitator, motivator, mediator and evaluator in learning.

The problem based learning model support system that was developed is the book model equipped with an explanation of problem based learning, learning steps, a brief description of the material, accompanied by student worksheets.

The problem-based mathematics learning model for SMK that has been developed in this study is one proof that the problem-based learning model can be used to facilitate students in mastering the mathematical concepts of SMK which so far tend to still use the lecture method.

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