International Journal of Academic Research and Development
ISSN: 2455-4197; Impact Factor: RJIF 5.22
Received: 09-06-2020; Accepted: 22-06-2020; Published: 10-07-2020
www.academicjournal.in
Volume 5; Issue 4; 2020; Page No. 62-66

Development of learning tools on geometry transformation subject matter with problem based learning models

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Abstract
The purpose of this study is to produce learning tools using the Problem Based Learning model on geometry transformation subject matter and to produce learning tools using Problem Based Learning models on valid, practical and effective geometry transformation subject matter. This research was conducted on students of class XI MIPA SMA UNKLAB. The number of students studied was 33 students. In this research the RPP, LKS, and THB models of Problem Based Learning are developed on the subject matter of geometry transformation. The development model used in this study is a modification of the 4D model. The results of this study stated that the products developed met valid, practical, and effective criteria. The average score learning device is 3.55 with valid criteria. The practicality results obtained from the learning device results from the ability of teachers to manage learning categorized as well located in intervals $3 \leq P < 4$ and student questionnaire responses that are above 73% positive student responses. The effectiveness of the learning kit is obtained from the Student Learning Outcomes Test which shows the value of mastery learning from students above 70.

Keywords: problem based learning, development, learning, transformation, geometry

1. Introduction

Mathematics is one branch of science that plays an important and necessary role in every aspect of human life. That is why strong mathematical mastery is needed from an early age to equip every student starting from elementary school. Strong mathematics education from an early age will equip students to acquire the ability to think logically, critically, creatively, and the ability to process, and utilize information to survive in ever changing circumstances.

Based on reality in the field cannot make students able to achieve satisfactory learning one of them in learning geometry transformation. Learning in schools that are often encountered still applies to learning that is still centered on the teacher. Teachers still have difficulty in designing learning tools that can improve students' mathematics learning success. Teachers also have not been able to improve optimal learning for students.

The teacher factor that is still having difficulty in designing learning devices and compiling learning devices is that the teacher does not yet fully understand the objectives and functions of the learning device and the most important is the understanding of learning models. So there are still many teachers who do not have complete learning tools when teaching.

Learning outcomes achieved by students after the learning process are not satisfactory. This is indicated by the large number of students who have not yet reached the KKM 75 score in the test. Based on the data found on the results of semester 2 of the XI class in the 2017/2018 school year at UNKLAB Adventist High School, namely Indonesian, English, Natural Sciences, Social Sciences, and Cultural Arts, they got an average score of 80, 82, 70, 75, 90 respectively. While Mathematics only get an average score of 67 from the minimum completeness criteria (KKM) 75.

The average value of Mathematics subjects has not yet reached the 75th KKM completeness score. After exploring why mathematics is so low in UNKLAB Adventist High School? Apparently it is caused by a learning process that is less attractive to students' learning interests.

As found, there are a number of things that make students in UNKLAB Adventist High School not yet reach KKM completeness value, which is according to interviews with some students that the results of some students do not like mathematics because mathematics is considered difficult to learn and understand.

Apart from student factors, factors found by the teacher were lack of teacher understanding of the learning tools and the processing of the learning process. The learning tools referred to in this case are RPP, LKS, and THB. Particularly in the lesson plan lesson is the use of learning models that are not in accordance with the subject matter to be presented. The learning model in the lesson plan is different from the application of the learning model when it is in the field (class). Time allocation that is not appropriate and most importantly the learning model chosen is still monotonous or learning models that still use learning models that do not activate students, tend students to become passive.

Most of the teaching materials used in learning mathematics in class XI high school only use textbooks, even though the characteristics of textbooks are already known to contain very dense material. In teaching material like this makes students less likely to be interested in reading it, while the LKS teaching materials are found, the form of LKS that is no different from the form of Student Learning Outcomes because the LKS used is only limited to the needs of student practice to work on the questions after the subject matter is finished delivered by the teacher. And especially in the THB

is the Learning Outcomes Test that is still not clear writing questions, and the teacher does not pay attention to the level of difficulty of the questions made. Then from the existing problems, researchers concluded the possible consequences of student learning outcomes that are lacking in UNKLAB Adventist High School.

Learning models include problems in learning that exist in schools to improve student learning outcomes, then one learning model that can actively involve student learning is the Problem Based Learning model.

The Problem Based Learning (PBL) model is rooted in the belief of Jhon Dewey in Abidin (2014) that teachers must teach by drawing on the natural instincts of students to investigate and create [1].

From various existing studies state that the true Problem Based Learning model is able to make students active in learning. The Problem Based Learning (PBL) model has already been applied but because the teacher does not really understand this learning model, this learning does not work. The teacher still has difficulty in carrying out these learning steps.

Based on some of the problems above, the researcher chose the Problem Based Learning (PBL) learning model is a type of learning that allows students to be more active and one of its advantages is to train student responsibilities. This learning model has a characteristic where the teacher only appoints a student to represent his group without telling in advance who will represent the group. So this method guarantees the total involvement of all students. This method is a very good effort to increase individual responsibility in group discussions.

In connection with the learning tools that must be prepared by the teacher when facing learning in class, then in this study, which was developed is a learning device to teach geometry transformation subject material using PBL models, to high school students in class XI which includes: Learning Implementation Plan (RPP), Student Worksheets (LKS), and Learning Outcomes Test (THB).

In the 2013 Permendikbud appendix explained that the Learning Implementation Plan (RPP) is a face-to-face learning plan for one or more meetings [2]. The RPP was developed from the syllabus to direct student learning activities in an effort to achieve basic competencies (KD).

According to the Ministry of National Education (2007), worksheets are sheets containing assignments to be done by students [3]. Assignments ordered in LKS must refer to the basic competencies that will be achieved by students. The activity sheets are generally in the form of a manual, steps in completing a task, where the tasks given are in accordance with the competencies to be achieved.

According to Purwanto (in Ngabidin, 2013) the test is a measurement tool for the process of data collection where in responding to questions on the instrument, participants are encouraged to show their maximum abilities [4]. Participants are required to put out their abilities as much as possible so that the data obtained from the results of the answers by students truly demonstrate their abilities.

Based on the above background, the researcher is interested in conducting research by developing learning tools for geometry transformation subject using Problem Based Learning (PBL) models.

2. Research Methods

The research method used is the development or Research and Development, in which in this study developed learning tools in the form of RPP, LKS, and THB.

3. Results And Discussion

Description of Development Results of Learning Devices

The purpose of this research is to produce a mathematics learning tool using the Problem Based Learning model of Geometry Transformation subject matter in class XII Adventist High School UNKLAB. The resulting learning tools are in the form of (1) Learning Implementation Plan, (2) Student Activity Sheet, and (3) Learning Outcomes Test.

This learning tool was developed based on a modification of the Thiagarajan (1974) model known as the Four-D Models with the following stages [5]:

Define Phase

At this stage the determination and definition of learning conditions are determined and defined. The details of the defining stage are:

1. Front-End Analysis

Front end analysis aims to bring up and determine the basic problems faced in learning mathematics in high school including curriculum and field problems so that the development of learning tools is needed.

Based on the results of surveys and interviews obtained information that in the implementation of learning geometry transformation in the classroom, the teacher teaches learning with no direction and often loses the main concepts. The learning kit is not provided by the teacher because the teacher is still having trouble making the learning kit.

2. Student Analysis

Student analysis was conducted to determine the characteristics of high school students which include abilities, background knowledge, and the level of cognitive development of students.

Based on student analysis, information was obtained that the Adventist High School UNKLAB already had basic geometry skills at the previous educational level (SMP) which became the basis for learning Geometry Transformation.

3. Task Analysis

Task analysis aims to find out the tasks that students must master to achieve Basic Competence in the Geometry Transformation subject matter in accordance with the 2013 Curriculum. From the results of the task analysis, it was found that the XI grade students at UNKLAB Adventist High School, on average did not yet have the ability in the concept of Geometry Transformation.

Based on some of these facts, it is necessary to develop a learning tool that can motivate students to actively participate in every learning of mathematics. Therefore according to researchers, it is necessary to develop a mathematical learning tool using the Problem Based Learning model. With this model students will be more active and motivated in learning activities so that they can improve their ability to solve problems related to the subject

matter they are learning.

Formulation of Learning Objectives

At this stage the formulation of learning objectives and indicators of achievement of competencies in the Geometry Transformation subject matter are carried out after conducting learning that is stated in terms of behavior. The learning objectives are a basis in the preparation of THB, Student Activity Sheets (LKS), and Learning Outcomes Test (THB) using the Problem Based Learning model.

Design

This stage has the aim to design learning devices, so as to produce prototypes (examples of learning devices). The design phase consists of:

1. **Initial Design**

The initial design in question is the design of all activities that will be carried out before the trial is carried out, that is, which will involve the activities of students and teachers in the form of lesson plans, worksheets, and THB.

2. **Format Selection**

The choice of format in the development of this tool includes the selection of formats for designing content, choosing learning strategies, and learning resources.

3. **Media Selection**

This stage is to determine the media that can be used for the presentation of learning subject matter. The process in selecting media is adjusted to the results of task analysis and analysis of subject matter, as well as student characteristics.

4. **Test Preparation**

The preparation of the test is the preparation of items in accordance with the basic competencies and indicators set at the defining stage. Preparation of tests based on task analysis and analysis of subject matter that has been spelled out in the learning objectives specifications. The test in question is the Learning Outcomes Test for Geometry Transformation subject matter. In designing the Student Learning Outcomes Test questions and score scoring grids used are Benchmark Reference Assessment (PAP).

Develop

At the development stage, steps include making the initial product that will be tested for validity by experts and practitioners, then revised according to the validation results. Validated products will be tested on a limited basis then revised again to be tested in the field. Then a revision is made based on the second trial to get the final product. The full set of steps in the development phase will be described in the following explanation:

1. **Pre Writing**

At this stage a reference is collected that will be used during the development phase.

2. **Manufacture of Initial Products**

The initial product is made according to the analysis done in the define stage in accordance with the design. At this stage an initial product in the form of learning tools will be obtained using the Problem Based Learning model.

3. **Expert Assessment**

Assessment by experts covers all learning tools developed at the design stage, namely RPP, LKS, and THB. The results of the validation from the experts in the form of suggestions are used as a reference to revise and refine the learning tools.

4. **Field Trial**

The learning kit uses the revised Problem Based learning model which is then tested in the field, namely to students. A trial was conducted to obtain direct input in the form of responses, reactions, comments from teachers, students, and observers in the field to the learning tools that had been prepared in the framework of revision.

5. **Revision of Learning Devices**

After passing through the initial stages of learning activities until the trial, improvements and revisions to the learning tools are carried out.

After conducting an expert assessment of the Learning Implementation Plan using the Problem Based Learning model that was developed, there are still a number of things that need to be revised so that the learning tools developed are truly appropriate for use in mathematics learning.

6. **Readability Test**

Before the trial is conducted, the readability test is carried out first. The readability test for Draft B was conducted on 7 students of class XI of SMA UNKLAB consisting of 3 high-ability students, 2 medium-ability students, and 2 low-ability students.

7. **Simulation**

Researchers simulate RPP and LKS. The simulation was followed by 15 students of class XI of UNKLAB high school and partner teachers. This class is not used for test classes. In this simulation, the researcher acts as a teacher with the aim that the partner teacher has an idea of how to implement learning in accordance with the learning tools developed by the researcher.

Phase 1 Trial of Learning Tools

Learning device testing aims to improve learning devices before the learning devices are used. This trial was held 4 meetings, according to the learning plan, and 2 meetings for pretest and posttest. The chosen class is Class XI IPA UNKLAB High School with 33 students.

The trial was also followed by 2 observers who had different tasks. One observer to observe student activities and another observer to observe the ability of the teacher to manage learning.

In this learning activity, students are grouped 5-6 people in one group, consisting of 1 student in the upper group, 3-4 students in the middle group, and 1 student in the lower group. Top, middle, bottom groupings based on previous math test scores and interviews and consultations with the teacher. Thus, it can be said that the average ability of each group is relatively the same.

Observation of student activities is carried out on 1 group consisting of 5-6 students consisting of 1 person each representing the top, middle, and bottom groups, for 4 times the implementation of learning. Observations are carried out continuously every four minutes (plus one minute to take notes) throughout the learning process.

The data obtained during the trial in the form of student activity data, ability data from the teacher managing learning, pretest data, post test data, and student response data. This data is analyzed, then the results are used as consideration for revision.

But in the tests conducted the value of the Student Learning Outcomes Test shows that there are still some students who have not yet reached the KKM or only 73% of students who have achieved the KKM. Therefore, the researchers revised the RPP and LKS.

Phase 2 Trial of Learning Tools

This phase 2 trial was held 4 times, in accordance with the learning plan, and 1 posttest meeting using revised learning tools.

In this learning activity, students are grouped 5-6 people in one group, consisting of 1 student in the upper group, 3-4 students in the middle group, and 1 student in the lower group.

The data obtained during the Phase 2 trial are posttest data. This data is analyzed, then the results are used as consideration for the final revision.

Analysis of the Effectiveness of Learning Devices

Analysis of the effectiveness of learning tools obtained from the analysis of student questionnaire responses and analysis of the ability of teachers in managing learning.

1. Analysis of Student Response Questionnaire

Based on data from the student response questionnaire that was filled out by 38 students after participating in learning activities for the Geometry Transformation subject matter using the Problem Based Learning model, the analysis results obtained that the students' responses to all aspects were above 75%. Therefore, every aspect responded positively by students.

2. Analysis of the Ability of Teachers in Managing

The results of observations on the management of learning by teachers during learning activities at the meeting reach the category of "good", which is located in the interval $3 \leq P < 4$.

Practical Analysis of Learning Devices

Analysis of the practicality of learning tools obtained from the analysis of student activities and completeness of student learning outcomes as follows:

1. Analysis of Student Activities

Observations of student activities during the learning activities take place are observed by an observer. Observations were made on 7 students consisting of 3 upper class people, 2 middle class people, and 2 lower class people.

The results of observations of student activities during learning activities obtained are within the criteria of effectiveness limits, and it can be said that the activities of students while participating in this learning are good.

2. Mastery of Student Learning Outcomes

Based on the completeness of the Phase 1 test, it was found that the percentage of the number of students who achieved completeness was included in both criteria with a percentage of 71.05%. Because the percentage of completeness did not reach 80%, a phase 2 trial was carried out by revising the RPP and LKS with the aim of completing the Learning Outcomes Test increasing after the Phase 2 trial.

Based on the Phase 2 trial, it can be seen that the percentage of the number of students who reach completeness is included in the excellent criteria with a percentage of 100%. This shows that the learning tools developed after the Phase 2 trial were effective in their use in learning activities.

Validity Analysis of Learning Devices

The validity analysis of learning tools is obtained from the validity and reliability data of the Learning Outcomes Test (THB) as follows:

1. Validity of THB Test Stage 1

Based on the product moment correlation formula, the level of validity of each test item is in the category of "high and very high". Then all test items can be said to be valid.

Based on research, the level of validity of each test item is in the category of "high", then all test items can be said to be valid.

2. THB Test Phase 1 Reliability

Based on the results of the study, the reliability coefficient $\alpha = 0.200$ was obtained. From the results obtained, the reliability of the Learning Outcomes Test instrument developed is included in the "low" category, and the instrument cannot be said to be reliable.

3. THB Test Phase 2 Reliability

Based on the calculation results, the reliability coefficient $\alpha = 0.68$ was obtained. From the results obtained, the reliability of the Learning Outcomes Test instrument developed is included in the "high" category, and the instrument can be said to be reliable.

So far, the learning tools developed are "valid" based on expert validation, "practical" based on the results of the ability of the teacher in managing learning which are categorized as good and students' responses to positive learning seen from the results of the student response questionnaire, and "effective" based on the analysis of student activities categorized as good and classically complete learning outcomes.

Thus, the learning tools that have been produced by researchers are Mathematics learning models Problem Based learning with an approach that meets the valid, practical, and effective criteria for Geometry Transformation subject matter in class XI of SMA UNKLAB. The resulting learning tools are in the form of lesson plans, worksheets, and learning outcomes tests.

Research Limitations

The mathematics learning tool developed in this study was limited to the Learning Implementation Plan, Student Activity Sheets, and Learning Outcomes Tests on the Geometry Transformation subject matter in class XI UNKLAB Adventist High School. With only three stages of the 4-D model. The trial was only conducted in one class, which consisted of 33 students.

4. Conclusion

1. Learning tools have been developed with the Problem Based Learning model on the subject matter of Geometry Transformation for class XI Adventist High School UNKLAB students and have fulfilled valid, practical, and effective criteria.
2. The validity of the device based on the Problem Based Learning model is shown from the validation results of

the validators on the device. The practicality of the device based on the Problem Based Learning model is shown from the results of observations.

5. References

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