GeoGebra-Assisted Problem Based Learning to Improve Mathematical Problem Solving Ability

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Abstract

The role of computers becomes an inseparable part of daily life, including as a media for learning mathematics, including making it easier to visualize 3D objects (building three-dimensional space). GeoGebra is software that can be used for mathematics education by combining geometry, algebra, and calculus. This research is an experimental research and the design used is the nonequivalent control group design. Sampling and sampling in this study using purposive sampling techniques. Based on the different test of the two average gain indexes, it was concluded that improving the problem-solving ability of students who studied using the GeoGebra-assisted problem-based learning approach was better than students who studied with conventional learning. The results of the attitude scale, it was found that in general students are positive towards mathematics learning by using the GeoGebra-assisted problem-based learning approach. The results of the bivariate correlation calculation concluded that there is a positive correlation between students 'attitudes towards learning using the application of GeoGebra-assisted problem-based learning and improving students' mathematical problem-solving abilities.

Keywords: problem based learning, GeoGebra, mathematical problem-solving ability

1. Introduction

The development of technology is now increasing with so many discoveries of software that make it easier for users and efficient in making, assembling and creating innovations in technology [1]. Some innovations in the field of software are not born from experts who have been involved for a long time in their fields, but from new people who think creatively about something that has not yet appeared. These innovations cover several fields, one of these software innovations is in the field of education, especially mathematics education which is quite rapid. Because maybe mathematics is still considered learning that is difficult to understand by students, experts create software that can help in solving math problems [2]. Some software can now be operated on the web online via the internet or can be operated on

a computer while offline (not connected to the internet network) [3].

The development of software that is user-friendly makes it easier for users by teachers and students in learning in class [4]. At least there are software programs/computer software that help in learning mathematics including Mapel, Cabri, Microsoft Mathematic, GeoGebra, Lindo, Grapmatica and many other software [5]. Each has its specificity in its use in learning mathematics.

One of the computer programs used in learning mathematics is GeoGebra software [6]. This GeoGebra software has many versions, including GeoGebra 4.4 and GeoGebra 5.0. Geogebra 5.0 can make it easier to visualize 3D objects (build three-dimensional space). This program is used in mathematics learning that is quite dynamic and software that can be used free of charge. GeoGebra is software that combines geometry, algebra, graphs, statistics, and calculus in one package that is easy to use for both teachers and students [7]. This educational software has received many awards in both Europe and the United States. Some of the strengths of GeoGebra include: 1.) Graphics, algebra, and tables are connected and very dynamic; 2.) Easy to use and many advanced features; 3.) A modifying tool for creating interactive learning materials as Web pages; 4.) Can be installed on Windows or Android; 5.) Available in many languages; 6.) Open-source software that is freely available for non-commercial users [8].

Various benefits of computer programs in mathematics learning [9] . According to him, computer programs are ideal for use in learning mathematical concepts that require high accuracy, repetitive concepts or principles, completing graphics accurately, quickly, and accurately.

One computer program that can be used as a medium for learning mathematics is the GeoGebra program. GeoGebra was developed by Markus Hohenwarter in 2001. According to Hohenwarter [10], GeoGebra is a computer program to teach mathematics especially geometry and algebra. The GeoGebra program complements various computer programs for learning algebra that already exist, such as Derive, Maple, MuPad, as well as computer programs for learning geometry, such as Geometry's Sketchpad or CABRI.

On the other hand, argues that GeoGebra is a dynamic mathematical tool for schools that combines geometry, algebra, and calculus. Thus, GeoGebra can construct points, vectors, line segments, lines, polygons (polygons) and can change dynamically .

Geogebra can be installed on a personal computer and used anytime and anywhere by students and teachers. For teachers, GeoGebra offers an effective opportunity to create an interactive online learning environment that allows students to explore various mathematical concepts. According to Hohenwarter [8], the GeoGebra program is very beneficial for both teachers and students. Some of the uses of the GeoGebra program in learning mathematics are as follows:

On this occasion with the implementation of Lecturer Research in Schools, in this case, will be examined by trying to use an alternative use of learning models that can stimulate student motivation and activity, namely the Geogebra-assisted Problem-Based Learning (PBL) model. This learning model emphasizes the importance of learning that begins with problems found in an everyday environment.

PBL is a learning that has essence that presents a variety of authentic and meaningful problem situations for students. The teacher not only gives knowledge to students, but also must build knowledge in his mind. Students have the opportunity to gain direct experience in implementing their ideas, this is an opportunity for students to find and implement their own ideas [11]. PBL is a learning environment that uses problems for learning, that is, before students learn a material they are required to identify a problem, whether faced by real or case study. The problem posed is such that students find the learning needs needed so that they can solve the problem [12]. While Geogebra is used as an aid for teachers in learning in order to deliver students' mathematical connections and check the truth of problem-solving given by the teacher done by students [13].

Based on the background above, this study aims to find out improved the problem-solving ability of students who studied using the GeoGebra-assisted problem-based learning approach and who studied with conventional learning, the response of mathematics learning by using the GeoGebra-assisted problem-based learning approach, and correlation between students 'attitudes towards learning using the application of GeoGebra-assisted problem-based learning and improved students' mathematical problem-solving abilities.

2. Method

2.1 Method

This research is an experimental study on the application of the GeoGebra-assisted problem-based learning approach to improve students' mathematical problem-solving abilities. The design used in this study is the nonequivalent control group design [14]. The sample used in this study was students of class X MIA 3 as an experimental class and X MIA 5 as a control class. Sampling in this study using the Nonprobability Sampling technique is a sampling technique that is found or determined by the researcher or according to expert judgment[15]. As for the withdrawal of the sample using the Purposive Sampling / judgmental sampling technique. Purposive sampling is a way of sampling by selecting subjects based on specific criteria set by the researcher.

2.2 Development of Teaching Materials

Software development for learning needs is stated by experts in various fields. Multimedia development methodology consists of 6 stages, namely concept, design, material collecting, assembly, testing and distribution [16]. Based on the stages of multimedia development above, the stages of development of GeoGebra-assisted mathematics teaching materials are as follows.

a. Concept

The concept stage is the stage to determine the goals and who the program users are (audience identification). Besides determining the type of application (presentation, interactive, etc.) and the purpose of the application.

The concept that was taken by the researchers aimed at learning trigonometry assisted by GeoGebra software with class X samples of high school level. Meanwhile, the application used is in the form of presentations and the purpose of the application of problem-based learning with the help of GeoGebra software.

b. Design

Design is the stage of making specifications regarding program architecture, style, appearance and material requirements for the program. GeoGebra can run algebraic and geometric constructions side by side. Making geometric constructs in Graph View using the geometry tools available on the Toolbar. At the same time, the corresponding coordinates in Graph View will be displayed automatically in Algebra View (Algebraic View). Furthermore, you can directly enter commands, algebra, or functions into the Input Bar using the keyboard. The GeoGebra display image is as follows.

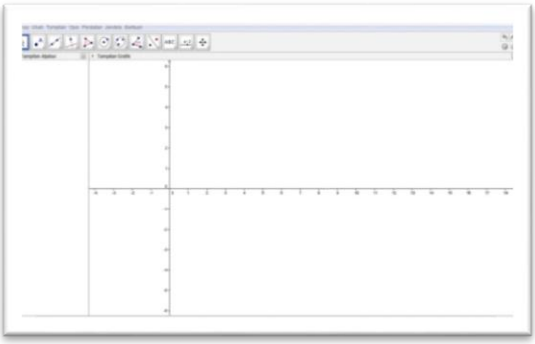

Fig. 1. Image Display of GeoGebra

The learning process carried out in the experimental class for trigonometric sub-topic material using GeoGebra Software in 3 meetings. The first meeting and the second meeting with the material on the comparison of trigonometry in right angles, special angles by using the application of the problem-based learning approach assisted by Geogegra software is illustrated with Graph View as Figure 2.

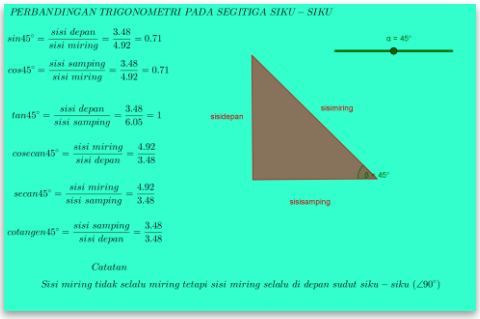

Fig. 2. Display of Trigonometry Comparison of Right Angles

At the third meeting of learning actions with GeoGebra-assisted problem-based learning approaches with trigonometric comparison material in various quadrants and related angles. The graph view is described as follows.

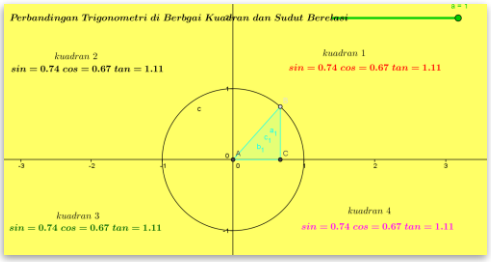

Fig. 3. Display of Trigonometry Comparison Material of Various Quadrants

c. Material Collection

Material Collection is the stage where material collection that suits your needs is carried out. This stage can be done parallel with the assembly stage. In some cases, the material collection and assembly stages are done linearly.

d. Assembly

Assembly (making) is where all objects or multimedia material is made. Making an application is based on the design stage.

e. Testing

Testing is done after completion of the manufacturing phase (assembly) by running the application/ program and see whether there are errors or not. This stage is also referred to as the alpha test phase (alpha test) where the test is carried out by the maker or the maker of the environment itself.

Testing aims to determine the extent of problem-based learning by using the developed GeoGebra software can meet the research objectives, namely improving students' mathematical problem-solving abilities. The results of this study were conducted by conducting media validation tests conducted by researchers. This media validation test was submitted to mathematical media experts.

For the media validation test, it was tested on four respondents who were considered experts in learning media, especially in developing GeoGebra software. Based on the results of testing conducted with the media validation test by the media experts above, it can show that the media created are in the very good category, so that the material for developing instructional materials is suitable for use in conducting research.

f. Distribution

Distribution is the stage where the application is stored in a storage media. At this stage, if the storage media is not enough to accommodate the application, then the application will be compressed.

3. Result and Discussion

From the description of the pretest results of the experimental class the average value of 7.00 and the standard deviation of 2.55 from the ideal score of 20, while the control class obtained an average value of 7.32 and the standard deviation of 2.96 from the same ideal score. Based on the similarity test of two pretest averages, it was concluded that the average initial mathematical problem-solving ability of the experimental class students was the same as the initial mathematical problem-solving ability of the control class students.

The results of descriptive analysis of the experimental class gain index value that the average value of the experimental class gain index with a sample size of 39 was 0.81 and the standard deviation value of 0.16 and the average value of the gain index with a sample size of 38 control classes namely 0.57 and standard deviation of 0.25. The difference in the average value of the experimental class and control class is 0.24. Based on the different test of the two average Gain indexes, it was concluded that increasing the problem-solving ability of students who studied using the GeoGebra-assisted problem-based learning approach was better than students who studied with conventional learning.

The results of the attitude scale given to the experimental class students who used the GeoGebra-assisted problem-based learning approach, found that in general students were positive towards mathematics learning by using the GeoGebra-assisted problem-based learning approach.

The correlation coefficient of students 'attitudes towards mathematics learning with the application of the GeoGebra-assisted Problem Based Learning approach with an increase in students' mathematical problem-solving abilities is 0.582, with a significance value <0.05 (0.000 <0.005) so that the correlation interpreted has a moderate level of relationship. From the value of the correlation coefficient can be obtained the value of the coefficient of determination that is equal to 33.88% This shows that student attitudes influence the improvement of students' mathematical problem-solving abilities.

The results of the bivariate correlation calculation, it was concluded that there is a positive correlation between students 'attitudes towards learning using the application of GeoGebra-assisted problem-based learning with an improve in students' mathematical problem-solving abilities that is equal to 94.92%. Other factors that affect the improvement of students' mathematical problem-solving abilities are quite large that is equal to 33.88%. Other factors can be caused by the ability of students themselves, internal and external motivation, and the seriousness of students in carrying out learning both at home and at school.

4. Conclusion

Based on the different test of the two average gain indexes, it was concluded that improving the problem-solving ability of students who studied using the GeoGebra-assisted problem-based learning approach was better than students who studied with conventional learning. The results of the attitude scale, it was found that in general students are positive towards mathematics learning by using the GeoGebra-assisted problem-based learning approach. The results of the bivariate correlation calculation concluded that there is a positive correlation between students 'attitudes towards learning using the application of GeoGebra-assisted problem-based learning and improving students' mathematical problem-solving abilities.

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