International Journal of Research in Mathematics Education
Vol. 1 No. 1, July 2023, 67-80
Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto
e-ISSN: 3025-7638, p-ISSN: 3025-1842

The Integration of GeoGebra in Problem-Based Learning to Improve Students' Problem-Solving Skills

Joko Suratno[1]✉, Ida Kurnia Waliyanti[1]

[1] *Universitas Khairun, Ternate, Indonesia*

✉ *Corresponding email:* *joko_unkhair@yahoo.co.id*

Received June 5, 2023
Accepted July 4, 2023
Published July 31, 2023

https://doi.org/10.24090/ijrme.v1i1.8514

Abstract: Learning mathematics requires the development of problem-solving abilities. However, problem-solving requires additional focus, particularly in the context of schools. Therefore, alternatives are needed to teach students how to solve problems through GeoGebra in problem-based learning. The goal of this study was to thoroughly and in-depth investigate how the use of GeoGebra in problem-based learning affects grade 8 students' capacity for problem-solving. Quasi-experimental research methodology is employed. The Posttest-Only Design with Nonequivalent Groups was the quasi-experimental design in this work. The quasi-experimental design in this study did not use pre-tests. This is due to the possibility that the initial test can affect the final test results. According to the data analysis, incorporating GeoGebra into problem-based learning significantly impacts students' ability to solve problems (p-value < 0.05).

Keywords: GeoGebra; problem-based learning; problem-solving.

A. Introduction

The science of mathematics plays various roles in people's and society's growth (Fatima, 2015). A person must cooperate and communicate with others in a social setting. Transactions and other activities, the majority of which cannot be separated from mathematics, can be considered types of cooperation and communication that take place. Additionally, humans need mathematics to further their cerebral development. Math problem-solving exercises aid in the development of pupils' thinking skills. These exercises will develop a positive, inventive mindset. Later on, this procedure would impact pupils' mental capacities in daily life.

Numerous societal areas, such as education, economic development, and science and technology, demonstrate the value of mathematics. Math is studied or required in practically every topic and course in education. Mathematics supports economics in terms of economic growth. In the development of science and technology, mathematics is used extensively in business and financial services, and as a result, science and technology are present. From social sciences to medical and medical sciences, mathematics is widely used in various scientific fields. The advancement of science and technology in this century has also made successful use of mathematics. This is demonstrated using mathematics in multiple domains, such as planetary exploration and biotechnology.

Mathematics must be continually improved to generate the range of mathematical knowledge needed by humanity as a force supporting science and technology. Various tools and technologies can be used in conjunction with this knowledge. Therefore, the need for additional mathematical expertise to enhance human life is excellent. Mathematicians play a crucial part in this talent, and the more mathematicians there are, the newer skills there are to learn.

One of the ways to create many mathematicians is by nurturing and educating students in solving mathematical problems in schools. Therefore, teachers need to increase their role in improving problem-solving skills in mathematics. However, most mathematics teachers currently produce students or graduates. One strategy for creating many mathematicians is to encourage and train pupils to solve mathematical problems in the classroom. As a result, teachers need to play a more significant part in enhancing students' ability to solve mathematical problems. However, most math instructors today generate graduates or students who need more knowledge or expertise to solve complex problems (Xavier, 2013). Additionally, even though some mathematics textbooks use conjectures in the presentation of the topic, modern educational activities have largely stripped mathematics of its distinctive features. This is evident from the simplified mathematical algorithms the teacher uses to explain the material, from the fact that students rarely learn why definitions, examples, theorems, and proofs are significant or fascinating, and from their perception that learning mathematics consists only of learning rigid rules and procedures (Wilson, 2003).

Only some students need to be math experts or have a strong math background. To deal with technological advancements and the advancement of the times, pupils must learn mathematics from a young age. As a result, teaching kids problem-solving abilities is crucial if they can recognize patterns in the continuously shifting, uncertain, and competitive world of real life. Students are expected to be able to forecast and resolve an issue that will be and is currently being encountered by identifying ways that occur in daily life.

Only in a suitable learning environment is problem-solving feasible in classroom learning activities. It is more likely to be employed as a problem-solving method because the national school curriculum requires a multi-strategy approach and technology. However, the fact that instructors' learning methods have stayed the same since then is daily news. Teachers of mathematics still provide material using traditional methods. Most math instructors rarely use technology in their lessons; hence the adoption of technology in math instruction advances relatively slowly. Additionally, some teachers have access to computers and the right software at work and home; nevertheless, the facilities and technology already in place are rarely incorporated into classroom instruction by the teachers (Zilinskiene & Demirbilek, 2014). Some teachers have access to computers and the right software at work and home, but they only sometimes incorporate the available resources into classroom instruction (Hardy, 1940).

The characteristics of learning activities that allow for improving problem-solving skills are learning activities in which there are activities that they enable students to be able to make observations. Of course, these observations are based on a task/activity and a problem that allows students to obtain different results, make mistakes, make improvements, and conclude the effects they have received. One alternative learning approach with these characteristics is problem-based learning (PBL) because, in PBL, it is possible to find several problem-solving solutions, which are the completion of a problem or activity. In addition, involving teachers in experimentation/observation activities and pain-solving with PBL provides teachers with new experiences about PBL. Exciting adventures and successful use of PBL are expected to encourage teachers' willingness to use PBL in their teaching activities (Cazzola, 2009). Besides PBL, technology can also be used in problem-solving activities (Colton, 2007).

Technology has affected the world of education at this time. This is due to the availability of various hardware and software and facilities or information and communications technology (ICT) that students can use for learning. ICT at least influences school subjects, knowledge, curriculum, how experts work, how teachers teach, how students work individually and in groups, and how students learn. This influence has consequences for teacher competence and implications for teacher education. Teachers must also be able to use these technologies in the classroom and laboratory (Cornu, 1999).

One of the technologies that teachers in classroom learning activities can use is the GeoGebra dynamic mathematics software. GeoGebra can be used in active and problem-oriented learning (Majerek, 2014). According to Evans (May 2013), the GeoGebra developer hopes that mathematics will be easy to understand with this software. He also wanted to show students that mathematics is beneficial and exciting. With GeoGebra, students can play with math. They can do something quickly, shift points wherever they want, can experiment with mathematics, and it is hoped that this method will make students understand better. Therefore, introducing GeoGebra is the right way to improve the quality of learning and is expected to improve student learning outcomes so that they are better (Kyeong, 2010; Ljajko, 2013). In addition, GeoGebra allows students to see abstract concepts, make connections, and discover mathematics (Antohe, 2009).

Padmavathy and Mareesh (2013) said that PBL has a more effective influence on learning mathematics than conventional learning in increasing students' understanding and use of mathematical concepts in real life. In addition, Leinwand and Burrill (2001) added that technology is essential in learning mathematics. However, integrating the GeoGebra dynamic mathematics software into learning activities with the PBL approach is challenging. More material on PBL training (Ward & Lee, 2002) and the availability of a computer laboratory are needed to guarantee the implementation of regular use of computers in classroom learning (Leikin & Zazkis, 2010). According to So and Kim (2009), several things that need to be improved in integrating technology into PBL are the lack of ability to connect ideas, knowledge, and action and the lack of teaching resources that integrate technology with PBL. Someone who can effectively integrate technology into learning usually has a good mastery of technology. However, someone with good skills in mastering technology can only sometimes use these skills in teaching. Therefore, it is indispensable for a teacher to master technology and how to use it in learning to achieve the objectives of learning activities.

One effort to encourage mathematical software to be used regularly in classroom learning is to train teachers to use the software (Gawlick, 2002). Kennedy et al. (2008) added that the correct use of computers and programs that are effective in learning would benefit students when learning using computers is applied in the classroom. However, computers will not help much if the software is not combined with the proper learning techniques. For example, student-centered learning methods, active learning methods, and learning through skills, practice, and experimentation.

The designed research is expected to provide new learning experiences in developing students' problem-solving abilities. Problem-solving in this study can be done with various learning activities. These activities can be in the form of activities to produce concepts, conjectures, theorems, and proofs. Identifying the shortcomings of a theorem, simplifying a proof, generating a new proof method, and finding techniques for constructing a concept can also be seen as problem-solving activities (Colton, 2007).

Creative learning activities to bring up mathematical problem-solving skills are closely related to mathematical situations or problems that can bring out the creativity in the classroom. The mathematical situations or problems in question are at least situations and problems familiar to everyday life. In addition, the situations and problems presented can be manipulated so that students can explore, provide sources of information for student questions, and provide materials and equipment that will encourage students to do experiments. Another thing that will be done is giving time to students to be able to manipulate, discuss, and experiment, encourage students not to be afraid of making mistakes that can later be corrected, and produce conclusions or success from these activities. Providing guidance, reflection, and reinforcement of students' ideas and hypotheses is also vital, in addition to providing positive feedback on student work. Researchers or teachers must know when or in what situations a student should be given guidance or assistance. Reflection is needed in students' understanding of the material provided, and reinforcement broadens or deepens students' mastery and knowledge of particular studies. Therefore, this research aims to provide new learning experiences so students can creatively produce problem-solving. This is done by combining problem-based learning with GeoGebra dynamic mathematics software, which aims to improve problem-solving skills.

B. Methods

The research method used is quasi-experimental. The main difference between this research and pure experimental research lies in placing individuals into groups. In experimental research, individuals are randomly selected to minimize bias. If individual selection is deemed impossible or impractical, quasi-experimental research is the right choice (Cohen et al., 2007; Muijs, 2004). Because the quasi-experimental design does not provide complete control, researchers need to pay attention to the factors that affect internal and external validity in interpreting the results of their research (Ary et al., 2009).

This study consisted of independent variables, namely problem-based learning assisted by technology, and the dependent variable, namely problem-solving skills. The quasi-experimental design used in this study was a Post-test-Only Design with Non-equivalent Groups (Prancan & Wise, 2002), as shown below.

$$NR\ X O_1$$

$$NR\ O_2$$

Information:

NR	=	*Nonrandom* (Not Random)
X	=	Problem-Based Learning Assisted GeoGebra
O1 = O2	=	Problem Solving Ability Test

The dotted line between the two sample classes, namely the experimental class and the control class, indicates that the two classes were not formed by randomly placing individuals or research subjects into sample classes (Prancan & Wise, 2002). Students who were subjects in the experimental class were taught using problem-based learning assisted by technology (X). In contrast, students used as research subjects in the control class were taught traditionally. At the end of the learning activity, students in both sample classes were given a final test (O1 = O2), namely a test to measure their problem-solving abilities.

The quasi-experimental design in this study did not use pre-tests. This is due to the possibility that the initial test can affect the final test results (Lana cit. Prancan and Wise, 2002). In addition, the problem-solving ability test is an unusual test for students. Students need to be trained in completing tests or questions of this type in the learning process. Therefore, giving the initial test in this study was eliminated.

This study's population was all class VII SMP Islam 1 Kota Ternate students. The experimental research class was class VII8, with a total of 21 students and the control class was class VII11, with 25 students with purposive sampel test. Before being given treatment, an initial mathematical ability test was carried out on the experimental and control classes. Based on data analysis on the results of this test, it is known that there is no significant difference in initial mathematical abilities between the two sample classes, so the two sample class groups are eligible to be used as research sample classes.

The main instruments of this research are Mathematical Preliminary Ability Tests and Problem-Solving Ability Tests. The initial mathematical ability test is used to measure students' understanding of the material studied and is thought to be supporting material in mastering the material of Triangles and Quadrilaterals. These materials include Numbers, Algebra, Lines and Angles, and Cartesian Coordinates.

The total number of items is 30. Before being tested, three experts assessed the test's quality. The assessment includes the suitability of the questions with the indicators; suitability of the material in question with competence; homogeneous and logical answer choices; the number of answer keys; formulation of the subject matter; suitability of the primary question formulation and answer choices; whether there are answer essential instructions; whether there are statements that are double negative in the main question; selection of homogeneous and logical answers in terms of material; clarity and functionality of pictures, graphs, tables, diagrams, or the like in the items that present them; the length of the answer choices; use of answer choices; sorting of answer choices; the dependence of the item on the answer to the previous question; the use of language in accordance with the rules of the Indonesian language; use of communicative language; use of local/taboo language; the selection of answers does not repeat the same word/group of words, unless it constitutes a unified understanding.

The three assessors stated that the items assessed were by the criteria in terms of suitability of the items with the indicators; suitability of the material in question with competence; homogeneous and logical answer choices; formulation of the subject matter;

whether there are answer essential instructions; whether there are statements that are double negative in the main question; selection of homogeneous and logical answers in terms of material; the length of the answer choices; use of answer choices; sorting of answer choices; the dependence of the item on the answer to the previous question; the use of language by the rules of the Indonesian language; use of communicative language; use of local/taboo language; the selection of answers does not repeat the same word/group of words unless it constitutes a unified understanding.

There are differences between the three assessors in terms of assessing the quality of the items in terms of the number of answer keys; suitability of the leading question formulation and answer choices; and the clarity and functionality of pictures, graphs, tables, diagrams, or the like in the items that present them. Therefore, the opinions of the three assessors need to be tested for diversity using the Q -Cochan statistic. The Q -Cochan test is used because the data from the three experts are dichotomous (Siegel, 1956). The analysis results show that the criterion for the number of answer keys shows the Asymp value. Sig. 0.465; the suitability of the main questions and the answer choices shows the Asymp value. Sig. 0.392; the clarity and functionality of pictures, graphs, tables, diagrams, or the like in the items that present them show the Asymp value. Sig. They amounted to 0.465. This shows that the probability value (sig.) is more significant than 0.05. Therefore, the three assessors gave uniform considerations that there was only one answer key, the main questions and answer choices were only necessary statements, and the image was clear and working. In addition, two out of three raters stated that the instrument could be used without revision, and one rater stated that the instrument could be used with minor revisions. Therefore, the researcher concluded that the instrument could be used without revision.

Problem-solving ability test tests will determine students' problem-solving abilities, including concepts, conjectures, theorems, proofs, simplification of proofs, and new method skills. Before use, this problem-solving ability test is tested for quality. The examiners are three experts. The assessment includes the suitability of the items with the indicators; suitability of question and answer limits; suitability of the material in question with competence; suitability of the content of the material being asked for with the level, type of school or class level; the use of question words or orders; clarity of how to do the questions; the existence of scoring guidelines; the communicativeness of the question sentence formulation; use of Indonesian; the use of words that will lead to multiple interpretations or misunderstandings; use of local/taboo language; and the use of words/expressions that can offend students.

The three assessors stated that the four items assessed had shown the suitability of the items with the indicators; suitability of question and answer limits; suitability of the material in question with competence; suitability of the content of the material being asked for with the level, type of school or class level; use of Indonesian; use of local/taboo language; and the use of words/expressions that can offend students. However, there are still differences among raters about assessing the items in terms of the use of question words or commands which requires explanatory answers; there are clear instructions on how to do the questions, there are scoring guidelines, the communicativeness of the formulation of the question sentences, and the use of words that will lead to multiple interpretations or misunderstandings. Therefore, it is necessary to test the uniformity of the assessment of the four assessors using Q-Cochran statistics.

The results of the analysis using the Q-Cochan statistics show that the criteria for using question words or commands, clarity on how to do the questions, communicativeness of the formulation of the questions, the use of words that will lead to multiple interpretations or misunderstandings all four have an Asymp value. sing. of 0.392, and the criteria for the existence of a scoring guideline shows the Asymp value. sing. of 1,000. This shows that the probability value (sig.) is more significant than 0.05. Therefore, it can be concluded that the three assessors gave uniform considerations that the four items used question words or commands that demanded detailed answers, there were clear instructions on how to do the questions, the communicative formulation of the questions, the use of words that would lead to multiple interpretations or misunderstanding, and there is a scoring guideline. In addition, two out of three raters stated that the instrument could be used with minor revisions and one rater stated that the instrument could be used without revision. Therefore, the researcher concluded that the instrument could be used with minor revisions.

Research data on students' problem-solving abilities will be analysed using SPSS (Statistical Product and Service Solution) assistance. Before testing, there will be the detection of outliers as well as testing of normality assumptions and homogeneity of the variance of research data, namely data on students' problem-solving abilities.

Outliers are detected using standard scores. Datums with standard scores around an absolute value of three should be suspected as outliers. This is because approximately 99% of normally distributed data should lie within three standard deviations of the average (Stevens, 2002). Therefore, data with a standard score of around three will be given special attention later.

The assumption of normality is a requirement of most inferential statistical procedures. SPSS provides two normality test formulas: the lilliefors normality test (Kolmogorov-Smirnov) and the Shapiro-Wilk Normality Test. In addition, a variance homogeneity test will also be carried out, both of which will be used to carry out the type of test that will be used next, namely parametric or non-parametric tests. If the assumptions of normality and homogeneity are met, the research hypothesis will be tested by paired-sample t-test with SPSS 20. If the assumptions of normality or homogeneity are not met, then the research hypothesis will be tested by the Mann-Whitney test.

C. Results and Discussion

The main objective of this study was to determine the impact of GeoGebra-assisted problem-based learning (PBL) on students' problem-solving abilities. The number of schools involved in this research is one. From these schools, two classes were selected as research samples. One of the two classes learns with GeoGebra-assisted problem-based learning (PBL+G), and the other learns conventionally. At the end of the learning activity, a test was carried out to measure student learning outcomes in the form of a problem-solving ability test. Table 1 below shows data on students' problem-solving abilities from the two class groups.

Table 1. Data of Students' Problem-Solving Ability

Approach	PSS average	Deviation Standards	The number of students

PBL+G	7,10	4,979	21
conventional	5,36	4,154	25

Notes. PSS = Problem Solving Skills
PSS Maximum Score = 23

The research data shows that the average problem-solving skills (PSS) of students in the PBL+G class is higher when compared to the PSS of students in conventional classes. Even so, the range of student scores in the PBL+G class looks more spread out than in the conventional class. This can be seen from the standard deviation of the PBL+G class, which is higher than the conventional class.

The PSS value in this study has the lowest value of 0 and the highest value of 23. When viewed from the maximum value of the PSS, the average value of PSS for the PBL+G class can be categorized as being in a low category, and the average value of the conventional class descriptively can be categorized in the value criteria as very low.

The assumption of normality is a requirement of most inferential statistical procedures. This study uses the SPSS 20 in carrying out the normality test. The groups to be tested were the PBL+G class and the conventional class.

Based on the normality test conducted on the PSS values, it was found that the PBL+G class showed a p-value < 0.05 for the Lilliefors (Kolmogorov -Smirnov) normality test and a p-value < 0.05 for the Shapiro-Wilk normality test. Both p-values are smaller than 0.05, so the PBL+G class data does not come from a normally distributed population. On PSS value for the conventional class, a p-value <0.05 was obtained for the Lilliefors (Kolmogorov-Smirov) normality test and a p-value < 0.05 for the Shapiro-Wilk normality test. Both p-values are smaller than 0.05, so conventional class data do not come from normally distributed populations for the Lilliefors (Kolmogorov-Smirov) normality test and the Shapiro-Wilk normality test.

The next test is for the similarity of variance or homogeneity of variance. The class being compared is the PBL+G class and the conventional class. The homogeneity test of student PSS data variance shows that the p-value for the variance homogeneity test is more significant than 0.05. This shows that the two groups, PBL+G and conventional, have the same variance. Even though the two groups have the same variance, they do not come from normally distributed populations. Based on the normality test and homogeneity of variance of PSS data, the statistical test used in this analysis is a nonparametric test. The nonparametric test used is the Mann-Whitney test. The Mann-Whitney test is an alternative to the independent two-sample t-test. Based on the analysis, it is known that ¬the p-value for the two-tailed test is less than 0.05, so it can be concluded that there is significant difference between the problem-solving abilities of PBL+G class students and conventional classes.

The main objective of this study was to determine the impact of GeoGebra-assisted problem-based learning on students' problem-solving skills. Therefore, various learning tools and research instruments were designed and prepared to achieve the intended research objectives. After making teaching materials, the next step is assessing the quality of teaching materials that have been made by involving several experts.

The research was conducted in a school involving 46 students. A total of one PBL+G class and one conventional class were selected from the school. At the end of the study, a learning achievement test was carried out to measure students' problem-solving abilities. The results showed no significant difference between classes taught by GeoGebra-assisted problem-based learners and classes taught by conventional methods. Thus GeoGebra-assisted problem-based learning has no impact on students' problem-solving abilities.

This study's ability to solve problems reflects a mathematical understanding consisting of four indicators. The four indicators used as tools to measure problem-solving abilities are finding, exploring, and interpreting the relationship between the properties of the angles in triangles and lines for triangles; finding, exploring, and interpreting the relationship between the properties of the midpoints of the sides of a quadrilateral and the shapes formed by the midpoints; discover, explore and interpret the relationship between the properties of a diagonal line and the area divided by the diagonal of a parallelogram; and find, explore, and interpret the properties of lines that are formed based on the relationship between diagonal lines, gravity lines, and lines that are parallel to the sides of the base of the trapezoid.

The first item indicator is finding, exploring, and interpreting the relationship between the properties of angles in triangles and lines for triangles. These indicators are used as guidelines in the formulation of the desired questions. In formulating the problem, the researcher chose an isosceles triangle which would be used as a problem that students had to solve. According to von Glasersfeld (2000), knowledge can only result from experience. Efforts to provide experience with problem-based learning assisted by GeoGebra mathematical software to gain knowledge about problem-solving have yet to meet expectations. This relates to basic skills students have not fully mastered, such as understanding symbols and terms in plane shapes and naming and types of plane shapes. Therefore, the effort to improve it is to reconstruct (Piaget, 1970) this basic knowledge through an improved learning design so that the advantages of PBL can be maximized. An example is maximizing the role of cooperation in groups where individuals can help one another construct knowledge through social and cultural interaction (Mason & Johnston-Wilder, 2004).

Essential knowledge that students have mastered is necessary for making conjectures by following the instructions in the problem correctly. Some of the students in this study indicated that they did not follow the instructions, and others still had problems using writing aids, such as compasses and protractors. Even though finding conjectures is the first step in finding mathematics (Wu & Chen, 2009), students' limited abilities will cause obstacles to getting the expected conjectures.

Analysis of students' problem-solving abilities between classes taught with GeoGebra-assisted problem-based learning and conventional classes on the four indicators of problem-solving ability showed no significant difference between the two groups in each indicator of problem-solving ability.

There are striking differences between the results of this study with several previous studies. Previous studies have shown that problem-based learning has increased students' mathematical abilities. Noer (2010) concluded that the quality of improving critical, creative, and reflective mathematical thinking skills and learning independence of students who received mathematics learning using problem-based learning was better than students who studied mathematics conventionally. Problem-based learning also results better than conventional learning in improving mathematical communication, problem-solving, and students' mathematical dispositions (Karlimah, 2010).

Armiati (2011) concluded that problem-based learning is superior to conventional learning in improving students' mathematical reasoning abilities, mathematical communication, and emotional intelligence. The ability of problem-solving, communication and mathematical representation of students who get problem-based learning are better than students who get conventional learning (Sabirin, 2011).

Combining problem-based learning with other models or strategies also shows promising results. This can be shown by the high-level mathematical thinking skills and independence of students whose learning uses a problem-based approach with a Jigsaw-type cooperative setting better than the high-level mathematical thinking abilities of students whose learning uses a problem-based approach (Ismaimuza, 2010). Sugandi (2010) also concluded that the critical thinking skills, creative mathematics, and attitudes of students who received problem-based learning with cognitive conflict strategies were better than students who received conventional learning. This combination implies that problem-based learning is a learning approach that does not rule out the possibility of being combined with other learning strategies or learning aids.

The results above show that a good learning approach or method successfully applied in a place is not necessarily appropriate or suitable for application in places, subjects, school levels, or other materials. Researchers who wish to study research related to technology must consider several things. First is selecting the correct method or approach to a subject matter and developing the student's abilities. This requires thinking about how to see the problems faced by students to find alternative solutions. The second is the allocation of time between activities in the laboratory and class. The amount of time spent in laboratory activities will undoubtedly affect students' ability to be measured.

Learning activities entirely spent in front of the computer will undoubtedly affect students' abilities or skills in using geometric construction tools, such as rulers, compasses, and arcs. One of the researchers' recommendations for researchers who study geometry problems with technology is that it is necessary to conduct research that examines the impact of the number of learning activities in the computer laboratory on students' abilities or skills in painting or constructing geometric objects and finding out the ideal percentage between the number of hours of activity in the laboratory and class so that students' skills in constructing geometric objects both using technology and manually are maximized.

D. Conclusion

The main objective of this study was to determine the impact of GeoGebra-assisted problem-based learning on students' problem-solving abilities. In general, this research activity has been carefully prepared, starting from the design and development of teaching materials and instruments, expert validation, and trials that conclude that the developed teaching materials and instruments are feasible and can be used further. This research took approximately four months. The first two months are used for testing teaching materials, and the remaining two months for field research. Based on the results of data analysis, students' problem-solving abilities through problem-based learning assisted by GeoGebra are significantly different from students' skills abilities through conventional learning. Although a descriptive review of the average PSA scores shows differences in the criteria for average scores between PBL+G and conventional classes, the characteristics of the data do not allow data on students' problem-solving abilities to be tested with parametric statistics. Therefore, the parameter used as a reference is the median data from the two study sample groups. Based on the nonparametric test of these parameters, it was concluded that there was significant median difference between the two study groups being compared. So, GeoGebra-assisted problem-based learning affect students' problem-solving abilities. The number of activities in class and the laboratory is the same: five meetings each. Therefore, it is necessary to pay attention to the number of meetings between the class and the laboratory. This study has yet to maximize teaching materials and learning tools that have been compiled, developed, and tested with good results. Therefore, researchers interested in using technology in learning need to pay attention to the number of meetings in the classroom and the laboratory because this will relate to the abilities of the students to be measured.

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