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The Effectiveness of PBL Model with STEAM Approach Assisted by Android Application on Students' Mathematical Problem Solving Ability

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ABSTRAK

Kemampuan pemecahan masalah matematis siswa kelas XI di madrasah aliyah masih rendah. Berdasarkan hasil tes awal yang diikuti 181 siswa, hanya 16,02% siswa tuntas KKM, sedangkan 83,98% belum tuntas. Maka dari itu, penelitian ini bertujuan untuk menguji efektivitas pembelajaran model PBL dengan pendekatan STEAM berbantuan aplikasi android. Desain penelitian ini adalah quasi experimental dengan posttest-only control group design. Kelas XI MIPA 7 sebagai kelas eksperimen dan kelas XI MIPA 2 sebagai kelas kontrol. Data terdiri dari tes dan dokumentasi. Instrumen tes yaitu posttest berbentuk uraian. Analisis data menggunakan uji-t dan uji-z. Hasil menunjukkan bahwa PBL dengan pendekatan STEAM berbantuan aplikasi android efektif dalam meningkatkan kemampuan pemecahan masalah matematis siswa kelas XI pada materi barisan dan deret. Penelitian lanjutan mengenai model PBL dengan pendekatan STEAM berbantuan aplikasi android masih perlu dilakukan, sehingga penerapannya dapat sesuai dengan perkembangan zaman.

ABSTRACT

The mathematical problem solving ability of class XI students at an islamic senior high school is still low. Based on the results of the initial test which was attended by 181 students, only 16,02% of students completed the KKM, while 83,98% had not. Therefore, study aims to analyses the effectiveness of PBL learning model with STEAM appr oach assisted by android application. The design of this study was quasi-experimental with a posttest-only control group design. Class XI MIPA 7 as the experimental class and class XI MIPA 2 as the control class. The data consists of tests and documentation. The test instrument is the posttest in the form of an essay. Data analysis used t-test and z-test. The results show that PBL with the STEAM approach assisted by an android application is effective in improving the mathematical problem solving abilities of class XI students on the material of sequences and series. Further research on the PBL model with the STEAM approach assisted by android applications still needs to be done, so that its application can be in accordance with the times.

1. INTRODUCTION

Mathematics is a science that requires understanding, not memorization. So that students must learn to understand and master mathematical concepts and methods of solving them, ranging from simple to complex (Kowiyah & Mulyawati, 2018; Narayani, 2019; Rostika & Junita, 2017). In studying mathematics, students are not only required to have the ability to count, but also the ability to reason logically and think critically in solving a problem. Through mathematics, students are also accustomed to solving problems that are not merely routine questions, but rather problems in everyday (Kowiyah & Mulyawati, 2018; Masjaya & Wardono, 2018; Szabo et al., 2020). There are 5 (five) mathematics learning standards, including: 1) mathematical communication, 2) mathematical reasoning, 3) mathematical problem solving, 4) mathematical connection, 5) mathematical representation (di Fuccia et al., 2012; Senk & Thompson, 2020). This is of course in accordance with the 4C competency aspects (Critical Thinking and Problem Solving Skills, Communicative Skills, Creativity and Innovation, and Collaboration) which have been regulated by the Ministry of Education and Culture regarding the implementation of 21st century skills development in the 2013 revised 2017 Curriculum Implementation Plan (Astuti et al., 2019; Hidayatullah et al., 2021; Selman & Jaedun, 2020). Therefore, one of the competencies that is expected to be achieved in the mathematics learning process is the ability to solve mathematical problems.

In the era of the industrial revolution 4.0, all things are required to be related to technology, including learning activities (Elita et al., 2019; Khasanah et al., 2021). The approach in learning mathematics that

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incorporates technology along with the application of other fields or disciplines, such as engineering, architecture, economics, art, culture, and so on, is called the STEAM (Science, Technology, Engineering, Art, and Mathematics) approach (Hawari & Noor, 2020; Jacques et al., 2020; Syahmani et al., 2021). Learning with the STEAM approach teaches children to solve problems, so that children can develop their knowledge. A good learning activity is when children can be directly involved in the learning process, and are able to develop known concepts by trying (Sa'ida, 2021; Syahmani et al., 2021). Through STEAM, students can have scientific and technological literacy so that they can be used as provisions for living in society and solving problems faced in everyday life (Afriana et al., 2016; Conradty & Bogner, 2020; Lou et al., 2017). The STEAM approach is based on STEM (Science, Technology, Engineering, and Mathematics) which is involved with aspects of art and design. By involving the arts, learning strategies will be more inclusive and interdisciplinary (Garza & Travis, 2019; Hau et al., 2020; Jacques et al., 2020).

Judging from the results of PISA 2018, Indonesia's score in mathematical literacy is 379. With this score, Indonesia is ranked 73 out of 79 participating countries. Indonesia's mathematical literacy score has decreased, because in 2015, Indonesia had a score of 386 (Mevarech & Fan, 2018; Warniatun & Junaedi, 2019). This shows that the ability of Indonesian students in solving study questions, giving reasons in answers, solving, and interpreting problems is still very low. This is supported by the results of previous research which found that students' mathematical problem solving abilities in Indonesia were still in a very low category (Asih & Ramdhani, 2019; Fuadi et al., 2017; Utami & Wutsqa, 2017). Indonesian students are not familiar with math problems that require logical and applied thinking. Students are still used to and prefer answers that are theoretical and procedural (Afriyanti et al., 2018; Hikmah et al., 2020). In order for Indonesia's score to increase, maximum effort is needed in improving and developing the abilities of Indonesian students, one of which is problem solving skills. Problem solving is an attempt to find a solution to a problem (Arfiani et al., 2020; Verschaffel et al., 2020). There are 4 (four) stages of problem solving, namely understanding the problem, devising a plan, carrying out the plan, and looking back (Jalinus et al., 2019; Polya, 1973).

In the observation of mathematics learning that has been carried out in class XI MAN 2 Kudus, questionnaire data was obtained with student respondents totaling 98 people. As many as 51,02% of students think that they have difficulty learning mathematics. In addition, 59,18% of students do not like learning resources or learning media in printed form. Students still expect mathematics learning resources other than books. This is evident from the response of 81,63% of students who need applications to support mathematics learning activities. Although 69,39% of students think that the mathematics taught is related to science, art, social, and culture, 50,00% of students admit that they have not been able to develop formulas to solve more complex mathematical problems. Then based on the problem-solving ability test which was followed by 181 students of class XI MAN 2 Kudus, the average problem-solving ability score was 58,75 with the predicate need for guidance. Of the 181 students who took the test, only 29 students or 16,02% of students completed the KKM 70. Meanwhile, 152 students or another 83,98% still did not complete the KKM 70. The results of the test showed that the problem solving abilities of the class students XI MAN 2 Kudus can be categorized as still low, so that special guidance or treatment is needed so that students' problem solving abilities can increase.

One solution to overcome problems in learning is to apply an interesting and fun learning model, so that students will be more enthusiastic and follow learning activities well (Bilqis et al., 2016; N. F. Sari, 2017; Suparman, 2016). In Permendikbud Number 59 of Year 2014 concerning the 2013 Curriculum for Senior High Schools/Madrasah Aliyah, it has been mentioned that several learning models can be applied to mathematics at the SMA/MA level. One of the learning models related to mathematical problem solving is the Problem Based Learning (PBL) model. PBL is a learning model that confronts students with a problem so that students can develop higher order thinking skills and problem solving skills and gain new knowledge related to these problems (Dwijanto et al., 2019; Hunaepi et al., 2014). In short, it can be said that PBL is a learning model that uses problems as a first step to gain new knowledge (Gorghiu et al., 2015; Lestari & Yudhanegara, 2017). The steps of the PBL learning model include: 1) student orientation to problems, 2) organizing students for learning, 3) guiding individual and group investigations, 4) developing and presenting work, and 5) analyzing and evaluating the problem solving process (Fitria et al., 2020; D. A. Sari et al., 2019).

The innovation of Android-based mathematics learning media has a characteristic that it always starts and is problem-centered. Students can work individually or in small groups to be able to recognize what is already known to solve problems (Hakim, 2018; Qurohman et al., 2019). There are 2 (two) ways to develop an android application, namely through programming and without programming. If the application is made using a non-programming method, then one of the software that can be used is Articulate Storyline. Articulate Storyline is a program that is supported by simple smart brainware with interactive procedures through templates that can be distributed online and offline, thus making it easier for users to create media in the form of websites, CDs, word processing, and Learning Management Systems (LMS) (Hardiyana, 2016; Heru, 2018; Rohmah & Bukhori, 2020). Android-based media or applications can also be created through Articulate Storyline (Amrita &

Kuswanto, 2019; Jubaerudin et al., 2021). With the advantages and convenience of making android applications using Articulate Storyline, the researchers chose Articulate Storyline to create android applications as a medium in learning activities. The application that has been designed by the researcher using the Articulate Storyline is named SI BADRI (Aplikasi Barisan Deret Aritmetika dan Geometri) or the Arithmetic and Geometry Series Application.

The SI BADRI application is a novelty from this research. SI BADRI contains material for arithmetic and geometric sequences and series that were studied in class XI semester 2 of the revised 2013 curriculum. SI BADRI has several features, including: 1) Materi Inti, in which there are formulas and a summary of the material, 2) Materi Terapan, consisting of the concepts of single interest, compound interest, annuity, growth, and depreciation, 3) Contoh Soal, including problem solving questions, 4) Video Penjelasan, to provide a deeper understanding of various kinds of questions related to sequences and series, 5) Kuis, as an evaluation tool and to hone students' abilities in solving series and series questions. SI BADRI has several advantages over similar applications that already exist on the Google Play Store, namely the material is more complete, there is applied material, 3 (three) types of quizzes are presented, there are examples of problem solving questions and discussion, and is equipped with an explanatory video.

Therefore, study aims to analyses the effectiveness of PBL learning model with STEAM approach assisted by android application. There are several objectives to be achieved in this study, including: 1) to test the average mathematical problem solving ability of students in the PBL learning model with the STEAM approach assisted by android applications compared to the average student ability in direct learning, 2) to test the average mathematical problem solving ability of students in the PBL learning model with the STEAM approach assisted by the android application against the minimum completeness criteria (KKM) 70, 3) to test the proportion of students who complete the KKM after following the PBL learning model with the STEAM approach assisted by the android application for all students in one class, and 4) to test the proportion of students who completed the KKM in the PBL learning model with the STEAM approach assisted by the android application compared to the proportion of students who completed the KKM in direct learning.

2. METHOD

This research is a quantitative research that has a research design in the form of a quasi-experimental design with a nonequivalent posttest-only control group design. At MAN 2 Kudus, there are several majors in class XI, consisting of 1 Language class, 7 Mathematics and Nature class, 3 Social Studies class, and 1 Religious Program class. Of these several classes, the population determined by the researcher is class XI MIPA, because class XI MIPA is a class with a focus on mathematics and natural knowledge, where students are of course required to have the ability to solve mathematical problems. Figure 1 show a chart of this research methodology.

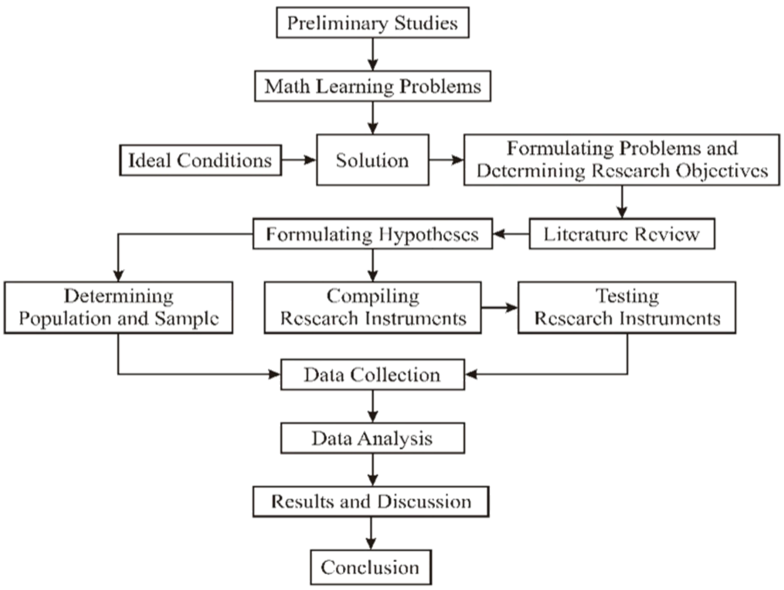

Figure 1. Research Methodology Chart

If the population is large so that it is impossible for the researcher to study everything in the population, the researcher can take a representative sample of the population, and the conclusions from what is learned from the sample can then be applied to the population (Lestari & Yudhanegara, 2017; Sundayana, 2018). The sampling technique used in this research is purposive sampling. This technique is a sampling technique based on certain considerations (Danuri & Maisaroh, 2019; Lestari & Yudhanegara, 2017). From 7 (seven) classes in the Mathematics and Natural Sciences department, the researcher took 2 (two) classes to be designated as the experimental and control classes. Class XI MIPA 7 was taken as the experimental class and class XI MIPA 2 was taken as the control class. The data collected in this study as a research instrument, namely an essay test. The test used by the researcher is a subjective test. The reason for choosing the subjective test is because the researcher wants to assess students' ability to solve problems, where finding the solution requires a thought process in several steps and each student must provide a solution strategy according to their knowledge and skills. The researcher only gave a final test (posttest) in this study. Table 1 is a grid of posttest instrument.

Table 1. Grid of Posttest Instrument

Indicator of Problem Solving	Sub Material	Question Description	Question Number
1. Build new mathematical knowledge through problem solving. 2. Solve problems that arise in mathematics and in other contexts. 3. Implement and adapt various appropriate strategies to solve problems. 4. Monitor and reflect on the mathematical problem solving process.	Arithmetic sequence	Presented the results of research on the growth of green beans through two growing media after a few days. The results of the study were in the form of a table containing the days and height of sprouts. Students can solve problems regarding the height of sprouts on certain days that are not mentioned in the research results.	1
	Single interest	Expressed the amount of money saved in the bank at the beginning of the month with single interest that can be obtained at the end of the month. Students can solve problems regarding the amount of money saved after 1,5 years, if there is an administrative fee per month.	2
	Arithmetic series	Presented paving blocks in a circle arranged in a row. Students can solve problems regarding the comparison of the number of paving blocks in the outermost row to the ranks in a certain order from the center of the arrangement, if the total number of paving blocks.	3
	Geometrical sequence	The initial number of bacteria at a given hour and the time required for one binary fission are presented. Students can solve problems regarding the number of bacteria after a few hours and the time it takes the bacteria to divide into a certain number.	4

Posttest is given after the learning is completed, with the aim that researchers obtain data that can be analyzed according to research objectives. In the posttest, the researcher tested the instrument first using the techniques of validity, reliability, discriminatory power, and level of difficulty as used in general. The validity test required is logical/theoretical validity (consideration of experts) and empirical validity (field facts). Empirical validity, reliability, discriminatory power, and level of difficulty refer to the test technique of subjective/descript instruments (Bashooir & Supahar, 2018; Lestari & Yudhanegara, 2017). The posttest consists of 4 (four) items of description. Based on the results of the posttest test, it was found that all the items used met the requirements of validity, reliability, discriminatory power, and level of difficulty, so that the posttest that had been prepared could be used as a research instrument.

Data analysis in this study is divided into 2 (two), namely initial data analysis and final data analysis, which begins with prerequisite tests. The prerequisite test consists of 2 types of tests, namely normality and homogeneity. Initial data analysis is an analysis of the mathematics learning outcomes of experimental and control class students. Statistical analysis of the data used a t-test (independent sample t-test) or a comparative test of two independent samples, to find out whether there was a difference in average between the two samples (Gandi et al., 2019; Lestari & Yudhanegara, 2017). The average initial ability of students in the experimental and control classes was tested, whether there was a significant difference between the two classes. While the final data analysis is an analysis of posttest results, with several hypothesis tests, including hypothesis testing 1 using a t-test (independent sample t-test) to compare the average abilities of students in the experimental and control classes, hypothesis testing 2 using t-test (one sample t-test) to determine the achievement of the average score of students in the experimental class on the KKM score, hypothesis test 3 uses the z-test of the proportion of one sample to determine the proportion of students in the experimental class who complete the KKM to the proportion of all students in the class, and hypothesis testing 4 using the z-test of the difference of two proportions to compare the proportion of experimental and control class students who completed the KKM.

3. RESULT AND DISCUSSION

Result

Initial Data Analysis

The initial data used to be processed in the initial data analysis is data on student learning outcomes in class XI MIPA 7 (experimental class) and XI MIPA 2 (control class). Table 2 contains a recapitulation of student learning outcomes in the two classes.

Table 2. Initial Data Recapitulation of Student Learning Outcomes

Class	N	Max	Min	$\sum X$	$\bar{X}$	Var	Std. Dev	Students pass the KKM	Students do not pass the KKM
Experiment	35	90	40	2290	65.43	190.252	13.793	15 (42.86%)	20 (57.14%)
Control	34	95	45	2400	70.59	148.128	12.171	21 (61.76%)	13 (38.24%)

If viewed directly, from Table 2 it can be seen that the average value of student learning outcomes in class XI MIPA 7 (experimental class) is 65,43. The average value of the experimental class can be said to be lower than the average value of student learning outcomes in class XI MIPA 2 (control class) which is 70,59. In addition, the average ability of the experimental class students is still below the KKM score of 70. The number of experimental class students who complete the KKM is only 15 people or 42,86% of the total students and the control class students who complete the KKM are 21 people or 61,76% of all students. This means that the proportion of experimental class students who complete the KKM is less than the control class students who complete the KKM. This means that before the treatment, the experimental class students' ability to solve mathematical problems was still lower than the control class. The results of the initial data normality test with the Kolmogorov-Smirnov test showed that at a significant level $\alpha = 0{,}05$, the significance value of the experimental and control classes was $0{,}200 > 0{,}05$, so it can be concluded that the initial data distribution of student learning outcomes was normally distributed. Then the results of the homogeneity test give the result that at the significant level $\alpha = 0{,}05$, the significance value of the two classes is $0{,}307 > 0{,}05$, so it can be concluded that the variance of the initial data of the experimental class and the control class is homogeneous variance. Initial data on student learning outcomes meet the prerequisites for normality and homogeneity, so that data analysis can be continued using parametric statistics. H_0 for this statistical test are $\mu_1 = \mu_2$ (there is no difference between the average score of student learning outcomes in the experimental class and the control class) and H_1 is $\mu_1 \neq \mu_2$ (there is a difference between the average score for student learning outcomes in the experimental class and the control class). The criteria for testing the hypothesis are if $-t_{table} \leq t_{score} \leq t_{table}$ or the value of Sig. (2-tailed) > α, then it is H_0 accepted. Table 3 shows the results of the initial data statistical test.

Table 3. Initial Data Statistical Test Results

		t	t_{table}	df	Sig. (2-tailed)	α	Information
Initial data	**Equal variances assumed**	-1.646	1.996	67	0.104	0.05	H_0 accepted

Based on Table 3, t_{score} for t value of homogeneous variance data is $-1{,}646$. In addition, the Sig (2-tailed) value is also obtained of 0,104. Then the results were analyzed based on the value $t_{table} = 1{,}996$ (via Microsoft Excel formula) and the value of $\alpha = 0{,}05$. Because the values t_{score} is $-1{,}996 \leq -1{,}646 \leq 1{,}996$ and Sig. (2-tailed) is 0,104 > 0,05, then it is H_0 accepted. That is, at a significant level of 5%, it can be concluded that there is no difference between the average value of student learning outcomes in the experimental class and the control class.

Final Data Analysis

The final data used for the final data analysis is the data from the students' posttest results. Table 4 contains a recapitulation of the posttest scores of the experimental class and control class students.

Table 4. Recapitulation of Final Data Posttest Results

Class	N	Max	Min	$\sum X$	$\bar{X}$	Var	Std. Dev	Students pass the KKM	Students do not pass the KKM
Experiment	35	100	62.5	2655	75.857	72.589	8.520	27 (77.14%)	8 (22.86%)
Control	34	90	53.75	2286.25	67.243	70.623	8.404	14 (41.18%)	20 (58.82%)

From Table 4, it can be seen that the average posttest score of class XI MIPA 7 (experimental class) is 75,857 and the average posttest score of class XI MIPA 2 (control class) is 67,243. That is, the average value of the experimental class students' ability to solve problems after treatment can be said to be higher than the control class. In addition, the average ability of the experimental class students is already above the KKM score of 70. It is also known that the number of experimental class students who have completed the KKM has reached 27 people or 77,14% of the total students, so the proportion of experimental class students who have completed the KKM is higher than 75%. While the control class students who completed the KKM were 14 people or 41,18% of the total students. This means that the proportion of experimental class students who complete the KKM is greater than the control class students who complete the KKM. Through the posttest results, it can be explicitly said that the experimental class students' mathematical problem-solving abilities became better after following the PBL learning model with the STEAM approach assisted by the SI BADRI android application.

The results of the final data normality test with the Kolmogorov-Smirnov test showed that at a significant level $\alpha = 0{,}05$, the significance value of the experimental and control classes was $0{,}200 > 0{,}05$, so it can be concluded that the distribution of the students' posttest data was normally distributed. Then the results of the homogeneity test give the result that at the significant level $\alpha = 0{,}05$, the significance value of the two classes is $0{,}817 > 0{,}05$, so it can be concluded that the variance of the final data of the experimental class and the control class is homogeneous variance. The final data obtained have met the prerequisites for normality and homogeneity, so that hypothesis testing is continued using parametric statistics. H_0 for hypothesis testing 1 is $\mu_1 = \mu_2$ (there is no difference between the average value of mathematical problem solving ability of experimental class students and control class) and H_1 is $\mu_1 \neq \mu_2$ (there is a difference between the average value of mathematical problem solving ability of experimental class students and control class). The criteria for testing the hypothesis are if $-t_{table} \leq t_{score} \leq t_{table}$ or the value of Sig. (2-tailed) > α, then it is H_0 accepted. Table 5 below shows the results of hypothesis testing 1.

Table 5. Hypothesis 1 Test Results

		t	t_{table}	df	Sig. (2-tailed)	α	Information
Final Data	**Equal variances assumed**	4.227	1.996	67	0.000	0.05	H_0 rejected

Based on Table 5, t_{score} for t value of homogeneous variance data is 4,227. In addition, the Sig (2-tailed) value is also obtained of 0,000. Then the results were analyzed based on the value $t_{table} = 1{,}996$ (via Microsoft Excel formula) and the value of $\alpha = 0{,}05$. Because the values t_{score} is $4{,}227 > 1{,}996$ and Sig. (2-tailed) is $0{,}000 < 0{,}05$, then it is H_0 rejected. That is, at a significant level of 5%, it can be concluded that there is a difference between the average value of the mathematical problem solving ability of the experimental class students and the control class. Furthermore, H_0 to test hypothesis 2 is $\mu_0 \geq 70$ (the average value of mathematical problem solving ability of experimental class students has reached KKM 70) and H_1 is $\mu_0 < 70$ (average value of mathematical problem solving ability of experimental class students has not reached KKM 70). The criteria for testing the hypothesis are if $t_{score} < -t_{table}$ or Sig. (2-tailed) $\geq \frac{1}{2}\alpha$, then it is H_0 rejected. Table 6 shows the results of the statistical test of hypothesis 2.

Table 6. Hypothesis 2 Test Results

	Test Value = 70			
	t	**df**	**Sig. (2-tailed)**	**Information**
Experiment Class (Final)	4.067	34	0.000	H_0 accepted

Based on Table 6, the value obtained t_{score} is 4,067. In addition, the Sig (2-tailed) value is also obtained of 0,000. Then the results are analyzed based on the value $\frac{1}{2}\alpha = 0{,}025$ and $t_{table} = 1{,}69092$ (via Microsoft Excel formula). Because the values t_{score} is $4{,}067 \geq -1{,}69092$ and Sig. (2-tailed) is $0{,}000 < 0{,}025$, then it is H_0 accepted. That is, at a significant level of 5%, it can be concluded that the average value of the mathematical problem solving ability of experimental class students has reached KKM 70. The conclusion on this hypothesis is in accordance with the average data values that have been described in descriptive data analysis.

Then the formula H_0 for testing hypothesis 3 is $p_0 \geq 75\%$ (the proportion of experimental class students who complete the KKM has reached 75% of all students in the class) and H_1 is $p_0 < 75\%$ (the proportion of experimental class students who complete the KKM has not reached 75% of all students in the class). The criteria for testing the hypothesis is if $z_{score} < -z_{table}$, then it is H_0 rejected. Table 7 shows the results of the statistical test of hypothesis 3.

Table 7. Hypothesis 3 Test Results

	P value on hypothesis = 0,75					
	n	**x**	p_0	z_{score}	z_{table}	**Information**
Experiment Class (Final)	35	27	0.7714	0.293	1.64	H_0 accepted

Based on Table 7, the value obtained z_{score} is 0,293. Then the results were analyzed based on the value z_{table} of the left side with a value of 1,64. Since the value z_{score} is $0{,}293 \geq -1{,}64$, it is H_0 accepted. That is, at a significant level of 5%, it can be concluded that the proportion of experimental class students who have completed the KKM has reached 75% of all students in the class. The conclusion on this hypothesis is in accordance with the data on the proportion of students that have been described in descriptive data analysis. The last hypothesis test is hypothesis test 4. H_0 for hypothesis 4 testing is $p_1 = p_2$ (there is no difference between the proportion of students who complete the KKM in the experimental class and the control class) and H_1 is $p_1 \neq p_2$ (there is a difference between the proportion of students who complete the KKM in the experimental class and the control class). The criteria for testing the hypothesis is if $-z_{0,5\alpha} < z_{score} < z_{0,5\alpha}$, then it is H_0 accepted. Table 8 shows the results of the statistical test of hypothesis 4.

Table 8. Hypothesis 4 Test Results

		n	**x**	**Complete Proportion**	z_{score}	$z_{0,5\alpha}$	**Information**
Final Data	**Experiment Class**	35	27	0.7714	3.042	1.96	H_0 rejected
	Control Class	34	14	0.4118			

Based on Table 8, the value obtained z_{score} is 3,042. Then the results are analyzed based on the value of $z_{0,5\alpha}$ =1,96. Because the value z_{score} is $3{,}042 \geq 1{,}96$, it is H_0 rejected. That is, at a significant level of 5%, it can be concluded that there is a difference between the proportion of students who complete the KKM in the experimental class and the control class.

Discussion

Testing hypothesis 1 gives the result that there is a difference between the average value of mathematical problem solving abilities of experimental class students and control class students. The results of testing this hypothesis strengthen the results of the final data recapitulation that has been obtained. Based on the final data recapitulation, it was found that the average posttest score of the experimental class students was 75,86 above the average posttest score of the control class students of 67,24. This means that learning the PBL model with the STEAM approach assisted by SI BADRI which is given to the experimental class has succeeded in increasing students' ability to solve more complex mathematical problems, especially in the material of arithmetic and geometric sequences and series. Testing hypothesis 2 gives the result that the average value of the mathematical problem solving ability of experimental class students has reached KKM 70. These results can of course be used as evidence that through the PBL learning model with the STEAM approach, the average score of students in solving math problems has been completed. If viewed from the initial data recapitulation, the average value of the experimental class students' learning outcomes is still below the KKM, which is 65,43. After the experimental class students were given treatment in the form of a PBL model with a STEAM approach, the average mathematical problem solving ability of students increased to 75,86.

Testing hypothesis 3 gives the result that the proportion of experimental class students who have completed the KKM has reached 75% of all students in the class. Based on this test, the data on the proportion of completeness of the experimental class students on the posttest results can be justified. In the posttest data recapitulation, the proportion of experimental class students who have completed the KKM is 77,14%, which is the value of learning outcomes in the initial data shows that the proportion of experimental students who have completed the KKM is only 42,86%. Through these results, it is clear that the number of experimental class students who have problem solving abilities has increased after the implementation of the PBL model with the

STEAM approach. This study had similar results to another study which resulted in a conclusion that after PBL learning was given, the proportion of students who completed mathematics problem solving abilities increased from the previous proportion (Sholihat & Amalia, 2019).

Testing hypothesis 4 gives the result that there is a difference between the proportion of students who complete the KKM in the experimental class and the control class. The results of testing this hypothesis can be used as a support for the results of the recapitulation of students' posttest scores. Based on the final data recapitulation, the proportion of experimental class students who completed the KKM was 77,14%, while the control class was only 41,18%. This means that the proportion of students who complete the experimental class is above the control class. The results of this study are in line with another study which give the results that students who study with the PBL model have higher average scores than students who study with the direct learning model, so that the PBL model in learning mathematics is proven to be more effective and effective. have a significant influence (Harisantoso et al., 2020) . In line with a similar study which obtained the results that the average value of students after being given the PBL model treatment also increased (Ahdhianto et al., 2020). In the study it was said that the PBL model was effectively used to catalyze mathematics learning in schools. That's because student-centered learning is designed to increase the active involvement and participation of students during learning. The idea to find a solution to the problem comes from the students' thinking. The teacher only acts as a facilitator in the PBL learning process.

PBL learning in research conducted by researchers begins with the presentation of problems through LKS (Lembar Kerja Siswa) or student worksheet. The problem-solving process until finding the solution in the worksheet is directly handed over to the students. Through learning activities from the worksheets that have been given, students with poor problem-solving skills will slowly follow a well-planned problem-solving mindset. Other researchers also suggested that the responsibility for solving problems rests on students in group work (Imam et al, 2018) . The LKS given to students has the aim of making students more focused in solving problem solving problems through the stages of problem-based learning. Problem-based learning can motivate students to arouse their curiosity, so that students' new knowledge and experiences will increase. Thus, the application of the PBL model of learning can give students the freedom to learn, receive information, transfer knowledge, and give opinions in the problem solving process in groups. Students also become accustomed to finding solutions in ways that are not the usual way, or in other words, students are trained to think more broadly (out of the box). This is in accordance with one opinion which says that the PBL model can train students' mathematical problem solving skills. When students discuss in their respective groups, students exchange opinions about how to solve problems (Monica et al, 2019) . Students' thinking abilities are truly optimized through a systematic group or team work process, so that students can empower, hone, test, and develop their thinking skills on an ongoing basis.

The STEAM approach used in this study also supports the achievement of the objectives of implementing the PBL learning model. In accordance with another study which succeeded in increasing the average score of students after applying the PBL model with the STEAM approach, because the PBL model with the STEAM approach allowed students to increase their independence in thinking and analyzing problems (Purwani et al, 2021) . STEAM provides opportunities for students to expand knowledge and improve 21st century skills. It can be said that because STEAM is an approach that can unite more than one discipline, both mathematics and other sciences, so that the knowledge students learn is holistic or comprehensive. This opinion is supported by opinions from other sources who say that the STEAM approach is more than just a science tool, but also a method that integrates learning into a holistic experience, addresses the complex problems of the 21st century, and is rooted in specific communities and environments (Garza & Travis, 2019). Therefore, the PBL model with the STEAM approach that has been applied to students is very useful to be used as a facility in improving students' mathematical problem solving abilities and is expected to be able to equip students in solving more complex life problems. This is in accordance with the opinion which states that the efforts that can be made by teachers to facilitate students' mathematical problem solving abilities are the PBL model with the STEAM approach, because this learning can make students accustomed to solving contextual problems by applying solving problem steps (Adifta et al., 2022).

The implication of android-based SI BADRI learning media used by students in finding information related to problem solving methods is also very useful to facilitate the learning process. Complete material, accompanied by examples of STEAM questions, explanatory videos, and various types of quizzes that have been provided, is a superior feature of SI BADRI that can help students learn interdisciplinary mathematical problem solving methods in a flexible and integrated manner, so that students' mathematical problem solving abilities will improve and getting sharper. This opinion is supported by the results of another study which conclude that the application of android-based learning media can improve students' mathematical problem solving abilities (Hikmah et al, 2020) .

One of the obstacles found by the researchers occurred in students who had smartphones -based iOS, so the Android-based SI BADRI application could not be installed on the smartphone. However, students who do not have an android smartphone can still open SI BADRI in HTML5 or SWF format. Suggestions that can be made for further research are if in learning activities there are media in the form of android applications such as SI BADRI, then it is better if the application is also created on an iOS basis and other operating systems, so that the application remains compatible if installed on various types of devices owned by students. Learning with the STEAM-based PBL model needs to be applied to other mathematics materials and developed with interesting learning steps so that students can be more active in learning activities and students' ability to solve interdisciplinary problems is increasingly honed. Further research on the application of the PBL model with the STEAM approach assisted by android applications such as those carried out by researchers still needs to be done, so that its application can be more relevant and in accordance with the times.

4. CONCLUSION

Based on the discussion of the hypotheses that have been presented by the researcher, the results obtained in this study are: 1) there is a difference between the average mathematical problem solving ability of the experimental class students and the control class, which is the average posttest score of the experimental class students. higher than the average posttest score of the control class students, 2) the average mathematical problem solving ability of the experimental class students has reached KKM 70, 3) the proportion of experimental class students who have completed the KKM has reached 75% of all students in the class, and 4) there is a difference between the proportion of students who complete the KKM in the experimental class and the control class, where the proportion of students who complete the experimental class is greater than the proportion of students who complete the control class. Therefore, it can be concluded that the PBL learning model with the STEAM approach assisted by the SI BADRI android application is effective in improving the mathematical problem solving abilities of class XI students on arithmetic and geometric sequences and series.

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