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Differences in Student Trigonometry Learning Outcomes Using Project Based Learning and Problem Based Learning Models

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Abstract

This study aimed to determine differences in trigonometry learning outcomes for class XI IPA students using project- and problem-based learning models. This study uses a quantitative approach. The subjects in this study were students of class XI IPA at SMAN 1 Tondano. The data collection technique was carried out by giving post-tests to students. The results of data analysis show that learning mathematics on trigonometry material experiences several obstacles, including When learning, students tend not to pay attention, students are not much involved in interpreting their knowledge, only receive information conveyed by the teacher, students tend to forget the material quickly, students are not able to solve problems that different from the example questions, the learning model applied is less effective. In addition, in this study, there are differences in trigonometry learning outcomes between students who are taught using the PjBL model with students who are taught using the PBL model.
Keywords: Learning Outcomes, Trigonometry, PjBL, PBL

Abstrak

Tujuan penelitian ini adalah untuk mengetahui perbedaan hasil belajar trigonometri siswa kelas XI IPA menggunakan model project-based learning dan problem-based learning. Penelitian ini menggunakan pendekatan kuantitatif. Subjek dalam penelitian ini adalah siswa kelas XI IPA SMAN 1 Tondano. Teknik pengumpulan data dilakukan dengan pemberian post test pada siswa. Hasil amalisis data menunjukan bahwa pembelajaran matematika pada materi trigonometri mengalami beberapa kendala diantaranya: Saat pembelajaran siswa cenderung tidak memperhatikan, Siswa tidak banyak terlibat dalam menginterpretasi pengetahuannya, hanya menerima informasi yang disampaikan guru, Siswa cenderung cepat lupa pada materi, Siswa tidak mampu menyelesaikan soal yang berbeda dengan contoh soal, model pembelajaran yang diterapkan kurang efektif. Selain itu pada penelitian ini dapat disimpulkan bahwa terdapat perbedaan hasil belajar trigonometri siswa yang diajar dengan menggunakan model PjBL dengan siswa yang diajar dengan menggunakan model PBL
Kata Kunci: Hasil belajar, Trigonometri, PjBL, PBL

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INTRODUCTION

Education is a conscious effort of humans to create themselves and society to sustain life in the current development of the times. Mathematics education is part of national education and is important in developing modern science and technology (Nursyeli & Puspitasari, 2021). Therefore, mastering and utilizing modern technology requires a sufficiently strong mastery of mathematics (Ningrum et al., 2019). So human resources are required to be reliable and competent in dealing with these various developments (Mangelep, 2017). These developments require many problem-solving skills that involve critical, logical, and systematic thinking (Sulistiani & Masrukan, 2017). These skills can be developed through mathematics education (Mangelep, 2017).

The results of observations at Tondano 1 Public High School located in Tondano, Minahasa, North Sulawesi Province, show that students still experience difficulties with trigonometry material. From the results of an interview with one of the mathematics teachers at SMA Negeri 1, Tondano also stated that the teaching and learning process in class was quite optimal. However, students still needed help solving trigonometry problems related to writing everyday life problems into mathematical models. Students also still need help in connecting between objects and concepts in mathematics. In addition, students also still need help determining what formula to use when faced with questions related to everyday life problems. This is because the learning model that is still applied is still teacher centered.

Data on Trigonometry learning outcomes for class XI students in the 2020/2021 school year found that 55% of students had to improve. This shows the low student learning outcomes in trigonometry material. For that, we need a learning model that can be used to solve the problem. In connection with this problem, a learning model is needed to involve students actively and provide opportunities for students to develop and find their understanding creatively. The learning model that can be used is the Project Based Learning (PjBL) model and the Problem-Based Learning (PBL) model.

The Project-Based Learning (PjBL) and Problem-Based Learning (PBL) learning models are just two of the many learning models that meet the criteria for innovative learning models. M. Hosnan (Mangelep et al., 2013; Slameto, 2017) states that "Project Based Learning or project-based learning models are learning models that use projects or activities as media." "The result of the project work is a product," according to the Buck Institute for Education (Slameto, 2017; Manambing et al., 2018), "which is not necessarily in the form of material, but can be in the form of presentations, plays, and other things that are presented in public and evaluated for quality." Students are required to learn and produce works as part of the project-based learning curriculum. As a result, this strategy can boost students' problem-solving abilities and group work collaboration (Mangelep, 2015). It can also increase their willingness to learn.

Bound and Feletti (Slameto, 2017) define problem-based learning as a method that creates a curriculum that compares students with issues and activities that serve as learning stimuli. According to Harrison (Slameto, 2017), problem-based learning is an approach to curriculum development and instruction that gives students a hands-on opportunity to address problems when they encounter less structured ones in the real world. As a result, problem-based learning is a teaching strategy that encourages students to work through learning challenges that are less regimented in the actual world. Students must learn from a problem or find a solution to an issue according to the problem-based learning approach. As a result, this model can motivate students to work hard, study in groups, and provide them the freedom to pick what they want to learn and how they want to acquire it (Mangelep et al., 2020).

Based on the benefits of the two cutting-edge learning models listed above, it can be concluded that Project-Based Learning (PjBL) and Problem-Based Learning (PBL) learning models can help students develop their critical thinking abilities while also improving their participation in learning, particularly in mathematics.

The two learning models were chosen by the researcher because they were more focused on the students. The PjBL model fully utilizes each student's capacity to develop a project. To foster higher-order thinking abilities, the PBL approach instructs and improves students' problem-solving skills using real-world challenges.

METHOD

The type of research used in this research is experimental research. "Experimental research methods are defined as methods used to find the effect of certain treatments on others under controlled conditions" (Sugiyono, 2017). The researcher will compare the Trigonometry learning outcomes data of students taught using two learning models (treatments), namely the Project Based Learning Learning Model and the Problem-Based Learning Learning Model. The research was conducted in class XI SMA Negeri 1 Tondando, with research subjects being class XI IPA 5 and XI IPA 4.

This research used a quasi-experimental method with a posttest-only control group design. The research design consisted of two predetermined samples/classes. These two classes were given different treatments: the Project Based Learning model in the experimental class and the Problem-Based Learning model in the control class. This research design can be seen in Figure 1 below:

R	X_1	O_1
R	X_2	O_2

Figure 1. Research Design

Information:

R: Random (Class Lawyer)

X1 : Application of the PjBL Learning Model (Experimental Class)

X2 : Application of the PBL Learning Model (Control Class)

O1 : Post-test of experimental class

O2 : Post-test control class

The data in this study were collected by administering tests to research subjects at the end of the lesson. The test given at the end of the lesson is called a post-test, which aims to determine the final ability of students in the experimental class and control classes.

The data analysis technique used in this research consists of two kinds: the prerequisite and the hypothesis tests. Before testing the hypothesis, the analysis prerequisites, namely the Data Normality Test and the Variance Homogeneity Test, were tested first. The data normality test uses the Lilliefors test, and the variance homogeneity test uses the Fisher test (F-test). After the prerequisite test, a follow-up test was carried out using the Mean Difference Test for Two Unpaired Groups

(Lolombulan, 2017). The statistical hypothesis is

$$H_0 : \mu_1 = \mu_2$$
$$H_1 : \mu_1 > \mu_2$$

Where μ_1 is the average parameter of trigonometry learning outcomes of students taught using the PjBL model and μ_2 is the average parameter of trigonometry learning outcomes of students taught using the PBL model.

RESULT AND DISCUSSION

The research data were taken from classes Class XI IPA IV and XI IPA V at SMA Negeri 1 Tondano, with 20 students in each class. The experiment was conducted in the odd semester of the 2022/2023 academic year, from September 5 to September 26, 2022. Descriptive Statistics of trigonometry learning outcomes data for students who were taught using the PjBL model in class XI IPA IV and students who were taught using the PBL model in class XI IPA V can be seen in the following table.

Table 1. Descriptive Statistical Data on Student Trigonometry Learning Outcomes

No.	Statistics	Student Learning Outcomes	
		PjBL	**PBL**
1	Maximum Score	95,00	90,00
2	Minimum Score	75,00	70,00
3	Total Learning Outcomes Data	1.740,00	1.575,00
4	Average	87,00	78,75
5	Standard Deviation (S)	6,96	6,86
6	Variance (S^2)	48,42	47,03

Based on Table 1, the average trigonometry learning outcomes of students who were taught using the PjBL model in the experimental class was 87.00, which spread from 75.00 to 95.00, while in the control class, the average trigonometry learning outcomes of students who were taught with using the PBL model is 78.75 which spreads from 70.00 to 90.00. The variance values of PjBL and PBL are 48.42 and 47.03, respectively, while the standard deviation or square root values of the variances of PjBL and PBL are 6.96 and 6.86, respectively, meaning that the spread of the data used is not too far from the average.

The normality test was carried out on two data, namely data on the PJBL learning model and data on the PBL learning model. In this study, the normality test of the data was done by looking at the Kolmogrov-Smirnov test data table. Smirnov is used to find out whether the data is normally distributed or not with the following conditions:

a. If $L_{count} < L_{table}$ then the data is normally distributed otherwise,
b. If $L_{count} > L_{table}$, then the data is not normally distributed. Can be seen in the Normality Test Table below:

Table 2. Normality Test

Class	N	L_{count}	$L_{table}\ (\alpha = 0{,}05)$	Description
Project Based Learning	20	0,142	0,190	Normal
Problem Based Learning	20	0.157	0,190	Normal
Conclusion: Normal Distribution				

Based on Table 2 above, classes with PJBL and PBL learning models have Lcount < Ltable from the results, the data is normally distributed. After all the prerequisites are met, namely, the research data is normally distributed, and the data is homogeneous (same), a hypothesis test is carried out using the independent test (T-test). An independent test (T-test) was conducted to determine whether there were differences in the results of the learning model using the PJBL and PBL learning models.

The hypothesis testing was carried out, namely hypothesis testing using the independent test (T-test) on the posttest for class XI IPA IV with the PJBL learning model and class XI IPA V with the PBL learning model. The decision-making criteria used sig 2-tailed 0.05, namely:

a. If the sig (2-tailed) value is <0.05, there is a difference between the PJBL learning model and the PBL learning model for Class XI students of SMA Negeri 1 Tondano
b. If the sig (2-tailed) value is > 0.05, then there is no difference between the PJBL learning model and the PBL learning model for Class XI students of SMA Negeri 1 Tondano

Hypothesis testing can also be done by looking at the tcount and ttable where the decision-making criteria are:

a. If tcount > ttable, then there is a difference between the PJBL learning model and the PBL learning model for Class XI SMA Negeri 1 Tondano.
b. If tcount < ttable, then there is no difference between the PJBL learning model and the PBL learning model for Class XI SMA Negeri 1 Tondano. Can be seen in Table 3 below:

Table 3. T-test

Post-test Data	Control Class	Experiment Class	t_{count}	t_{count}
N	20	20	3,776	3,776
Var.s	47,039	48,421		

The output of Table 3 above shows that the value of tcount = 3,776 and ttable = 2,024. Following the hypothesis testing criteria, H0 is rejected, and H1 is accepted.

This research was conducted to determine whether there is a difference between the Project Based Learning learning model and the Problem-Based Learning learning model in class XI IPA IV and XI IPA V at SMA Negeri 1 Tondano. There are differences in learning outcomes from the data on student learning outcomes using the PJBL learning model and the PBL learning model.

Student activities in projects implemented in Trigonometry learning positively influence the learning process, wherein students play a role in the projects they work on in groups. This is because each group looks for topics they will work on; using the PBL learning model, students are more active

in interacting with new things so that students will ask questions and explore more deeply about things they do not know; the first thing done in this PjBL is the researcher asks basic questions to students with Trigonometry material then students are directed to prepare project plans, In this phase students can play an active role because the schedule is carried out in groups as well as the selection of activities that support answering the fundamental questions asked by previous researchers, so students will certainly feel "owned" in the project they are working on.

Then the researcher and the students compile a schedule of project activities to be carried out; this also makes the swamp understand the process of collecting time because they are directly involved after the rogues of the research schedule monitor the project being worked on by Sawa, the researcher is responsible for directing and assisting students while working on the project.

After the project was completed, the researcher assessed the project results to determine the achievement of competency standards and the progress of each student. And then evaluated, reflected, and expressed feelings and experiences during the project's making.

This positively influences students because it makes it easier for them to understand the learning material. After all, learning is carried out independently, according to what Herawati (2019) said requires a strategy in learning. After all, this is one of the important factors that educators can use to facilitate the provision of learning material to students. One way is to choose a more innovative learning model. Furthermore, applying the learning model is an important factor in the learning outcomes obtained by students (Andayani et al., 2017; Tiwow et al., 2023).

The current era of learning requires innovation in every process. In the teaching and learning process, students should not be used as a library that can receive everything explained by the teachers in the hope that learning outcomes will increase; this raises a new idea, a breakthrough in research related to innovation in learning activities, especially learning models that do not only measure the results of student learning through learning that has been implemented so far by educators (Nur'Azizah et al., 2016; Kambey & Mangelep, 2019), this requires educators to be more creative in the learning process so that the results achieved can be maximized (Afriansyah, 2017). There are so many ways that can be used for maximum results in terms of quality of education, one of which is by applying a consistent and effective learning model with learning methods that make students active (Mundung et al., 2021; Rompas et al., 2023)

The learning model shows that the PjBL model is higher than the PBL model, where both learning models are student-centered and provide different learning experiences for students. The PjBL and PBL models apply different concepts in the teaching and learning process. PjBL is based on the products produced in the learning process, and PBL focuses more on students solving problems given by the teacher (Domu et al., 2023). By applying the Project Based Learning learning model to learning, students are active in generating, solving, and developing a project directly, and the learning atmosphere will be more enjoyable (Sari & Angreni, 2018). Then the project-based learning process. The student-centered learning model for conducting in-depth research on participant topics. Students

use research-based models to deepen their learning to constructively solve substantive and relevant problems (Runtu et al., 2023).

CONCLUSION

Based on the results of the research and discussion described in Chapter IV, there are differences in trigonometry learning outcomes between students who are taught using the PjBL model and those who are taught using the PBL model. From the results of this study, here are some suggestions that researchers want to put forward for the sake of the advancement of education, especially in SMA Negeri 1 Tondano (1). which is also good, (2) For teachers to maximize the learning process with the project model (PjBL) because the results of the research prove that learning with the meter project model can make students more active, easy to understand, and enthusiastic in the learning process, (3) For the school so that every implementation of learning in schools should include a project learning model because it has proven effective for students to understand the lessons given, (4) For further research to further develop this project-based learning model.

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