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The Influence of the PBL Model Using a Differentiated Approach to Substance and Its Changes Topics on Student Learning Outcomes

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Abstract: This research aims to determine the effect of the Problem-Based Learning (PBL) model through a differentiated approach to substance and its changes topics on student learning outcomes at SMP Negeri 12 Gorontalo. This research is experimental research, with the research design being One Group Pretest-Posttest Design. The population of this research is class VII students of SMP Negeri 12 Gorontalo. The sample consists of 3 classes, namely experimental class, replication 1, and replication 2, with the total sampling technique. The instruments used in this research are learning style tests, teaching modules, LKPD, teaching materials, and written tests (pretest-posttest) to see student learning outcomes. Then, the data is analysed using descriptive and inferential statistics, including normality tests, hypothesis tests, and n-gain analysis. The average score for class VII students is greater than the achieving learning objectives, shown by the average score of the experimental class of 78.08, replication 1 at 78.53, and replication 2 at 77.73, compared to the achieving learning objectives of 70. Based on hypothesis testing criteria where t is calculated in the experimental class, it was 5.404 compared to a t-table of 2.056; replication 1 obtained a t-count of 6.006 with a t-table of 2.037; and replication 2 obtained a t-count of 5.199 with a t-table of 2.064. It can be concluded that hypothesis testing in the three classes is t-count greater than t-table. Through a differentiated approach, the PBL model affects student learning outcomes.

Keywords: Differentiated, Learning outcomes, PBL model, Substance

INTRODUCTION

Education plays an essential role in the development and realization of every individual. It can be said to be a tool to achieve happiness and prosperity for all mankind. Quality education will reflect a progressive, peaceful society and lead to constructive traits. Of course, this is the focus of all stakeholders, giving rise to various concepts of curriculum changes that are carried out to adapt to existing conditions (Faiz et al., 2022). Learning can be interpreted as a process, method, or act of making humans living creatures to learn (Hidayat & Juniar, 2020). Learning combines human elements, materials, facilities, equipment, and procedures that influence each other to achieve learning goals (Harefa et al., 2020). Learning objectives can be achieved if they accommodate all the needs and characteristics of students in the learning process. Teachers, as educators and facilitators, must have the ability to design learning according to the characteristics of students (Naibaho, 2023). One learning approach that can accommodate all the needs and characteristics of each student is differentiated learning.

Differentiated learning is an effort or process to adapt the classroom learning system to each student's learning needs and abilities. In the principle of differentiated learning, each student has unique abilities and different ways of understanding knowledge or subject matter. Differentiated learning is a series of activities in the form of decisions prepared by the teacher to carry out pro-student learning and oriented toward their learning needs. These decisions relate to creating a learning environment, defining learning objectives, and a continuous assessment process to create a practical class (Fitra, 2022). The problem-based learning (PBL) model has several advantages that make it suitable for classroom learning, namely, making students learn and process, not just memorizing, increasing student activity, and solving problems by collaborating with fellow groups constructed by students through teacher guidance. The PBL

Model is directly related to problems in the surrounding environment or to students' real lives so that they not only learn just knowledge but can also feel and experience. Students make exploration, assessment, interpretation, synthesis, and information to produce various learning outcomes. The PBL model can also make the class atmosphere enjoyable and students more enthusiastic in the learning process because it requires students to learn from everyday life so that learning objectives can be achieved and improve learning outcomes (Bhoko et al., 2023).

The result of learning is overall change, not just one aspect of human potential. Learning outcomes have an important role in the learning process. The process of assessing learning outcomes can provide information to educators regarding students' progress in achieving goals and achieving the targets expected by educators (Maria et al., 2023). Based on the results of interviews with the class VII science teacher in SMP Negeri 12 Gorontalo, students still have difficulty understanding science topic. Apart from that, during learning, students are less active or tend to be passive and pay less attention, resulting in poor learning outcomes. So through, interesting learning models and approaches are one effort in the learning process that can significantly contribute to various learning systems because they help in teaching and make it possible to build a learning atmosphere that is not monotonous.

The problem above is solved using the PBL model through a differentiated approach. Applying the PBL model can improve students' thinking abilities and help them use their original knowledge and problem-solving processes that uniquely use their understanding and are directed toward a solution to a problem. Through a differentiated approach, it can also increase student involvement in learning activities in class. Apart from that, it helps students understand the learning context according to the stages of understanding, increases student interest, and helps students become more active by asking or answering questions from the teacher (Nawati et al., 2023). Based on the background description above, researchers are interested in conducting research about the influence of the PBL model using a differentiated approach to substance and its changes topics on student learning outcomes at SMP Negeri 12 Gorontalo.

METHODS

The type of research is experimental, and the research design used is the One Group Pretest-Posttest design in Figure 1. The steps taken in the experimental research were: 1) giving a pretest to the three classes; 2) providing the same treatment to the three classes using the PBL model through a differentiated approach; and 3) giving a posttest to all three classes.

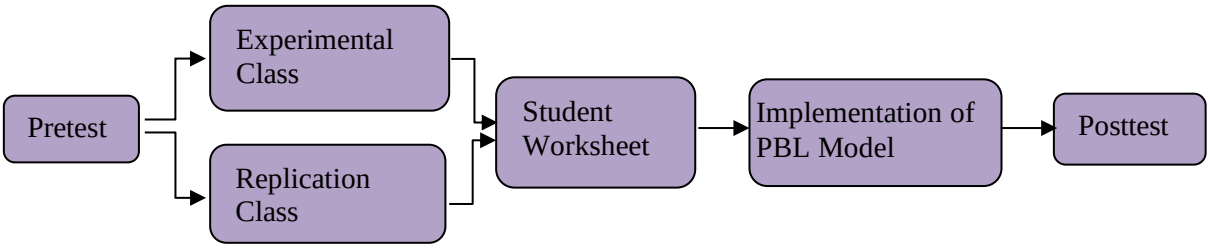

Figure 1. The flow chart of research

FINDINGS AND DISCUSSION

The research population was class VII students of SMP Negeri 12 Gorontalo for the 2024/2025 academic year. The selected samples were class VII-2 as the experimental class, VII-1 as the replication 1, and class VII-3 as the replication 2. The replication class in This research is a repetition of the experimental class to produce better estimates and see the results' consistency (Abdjul et al., 2022). According to Ngadi et al. (2024), the use of replication classes is a repetition of experimental classes to produce more accurate assessments and evaluate the results' consistency. The number of students in each sample group consisted of different numbers, namely class VII-1, 32 people; class VII-2, 26 people; and class VII-3, 24 people. The sample in this study was taken from the total population, namely 82 people. The determination of the sample group was random by drawing lots.

This research used a learning outcomes test, which was an essay with 11 questions covering the cognitive domain of levels C2, C3, C4, and C6. The aim was to determine student learning outcomes. The values obtained from the learning outcomes tests were then subjected to data analysis, including normality tests, hypothesis tests, and n-gain tests, to determine the effect of treating the PBL model through a differentiated approach.

FINDINGS AND DISCUSSION

Table 1. Calculation Results of Average Student Learning Outcomes

Class	Average Value	
	Pretest	Posttest
Experimental	46.42	78.08
Replication 1	47.33	78.53
Replication 2	43.14	77.73

Table 1 shows the average student learning outcomes, showing a difference between the average Pretest-Posttest scores for each class, both experimental classes, replication 1, and replication 2. The average learning outcomes in the Posttest for both experimental and replication classes exceed the average learning outcomes on the Pretest. Students' cognitive learning outcomes are obtained from the tests they carry out, which are arranged based on question indicators and cognitive level. The average achievement of each student's cognitive domain from cognitive levels C2, C3, C4, and C6 in the experimental class can be seen in Figure 2.

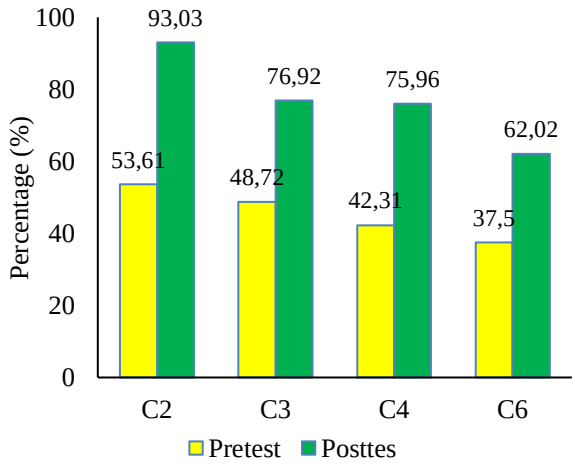

Figure 2. Average Student Learning Outcomes in the Experimental Class

Based on Figure 2, the average calculation results for each achievement of cognitive levels C2, C3, C4, and C6 showed an increase from the pretest to the posttest. C2 cognitive level increased by 39.42. At the cognitive level, C3 experienced a rise of 28.2; cognitive domain C4 was 33.65; and C6 was 24.52. So, a higher increase occurred at the cognitive level of C2. On C3 and C4, the growth is more significant than on C6. Then, the average achievement of each student's cognitive domain from cognitive levels C2, C3, C4, and C6 in replication 1 can be seen in Figure 3.

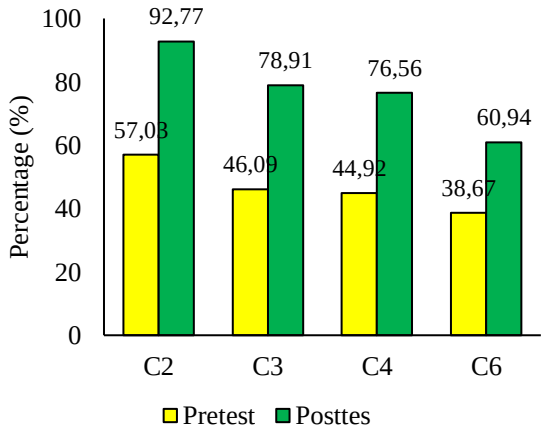

Figure 3. Average Student Learning Outcomes in Replication 1

Based on Figure 3 in replication 1, the average calculation results for each achievement of cognitive levels C2, C3, C4, and C6 have increased from the pretest to the posttest. C2's cognitive level increased by 35.74. C3's cognitive level increased by 32.82; cognitive domain C4 was 31.64; and C6 by 22.27. So, in replication 1, a higher increase occurred at cognitive level C2, and cognitive levels C3 and C4 had a more significant increase than C6.

The average achievement of each student's cognitive domain from cognitive levels C2, C3, C4, and C6 in replication 2 can be seen in Figure 4. Based on Figure 4 in replication 2 shows that the average calculation results for each achievement of cognitive levels C2, C3, C4, and C6 have increased from pretest to posttest. In cognitive C2, there was an increase of 43.75. C3 cognitive level increased by 32.3; cognitive domain C4 was 35.41; and C6 was 25. So, in replication 2, a higher increase occurred at cognitive level C2, and cognitive levels C3 and C4 had a more significant increase than C6. The

experimental class and replication 1 and 2 more substantially increased cognitive level C2 compared to C3, C4, and C6. According to Syari et al., (2023), students' abilities are only at the cognitive level of remembering and understanding, the lowest level in the cognitive domain criteria. Students have not been able to apply basic knowledge to solve complex problems and have not been able to make conclusions and processes. Form a general idea or conclusion from a problem.

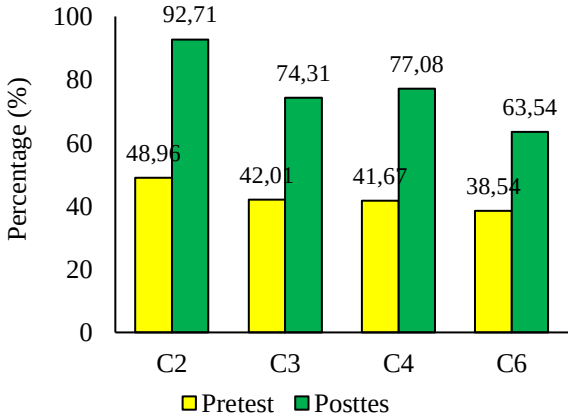

Figure 4. Average Student Learning Outcomes in Replication 2

N-gain Test

The n-gain test aims to see improvements in student learning outcomes through pretest and posttest test results using the course average normalized gain. The average n-gain score for student learning outcomes shows in Table 2.

Table 2. N-gain Test Results

Class	N-gain	Criteria
Experimental	0.60	Medium
Replication 1	0.60	Medium
Replication 2	0.61	Medium

Based on Table 2, the n-gain category in the experimental and replication classes falls into the medium criteria. Analysis of n-gain per indicator was also carried out to determine the increase in students' understanding of concepts for each indicator question on substances and their changes topics. The results of the n-gain analysis can be seen in Figure 5. The average calculation result in Figure 5 of the N-gain test for the experimental class is 0.60. In replication 1, it was 0.60, and in replication 2 was 0.61. So, the n-gain test in the three classes is at the same criteria, namely medium, but replication 2 is higher.

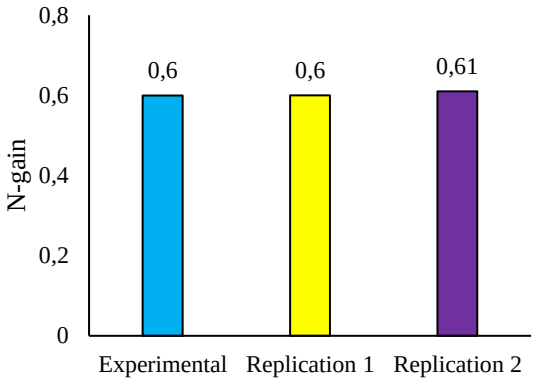

Figure 5. Average n-gain per indicator

Normality Test

This research uses the Kolmogrof-Smirnov normality test formula with the help of Microsoft Excel. The results obtained from statistical tests can be seen in Table 3 of the following data normality tests.

Table 3. Data Normality Test Results

Class	Fi	K	Status
Experimental	0.47	0.25	Normally distributed
Replication 1	0.48	0.23	Normally distributed
Replication 2	0.47	0.26	Normally distributed

The results of data normality testing, shown in Table 3, show that Fi ≥ K for the real level α = 0.05. Thus, it can be concluded that the research data for the experimental class, replication 1, and replication 2, are normally distributed.

Hypothesis Testing

Hypothesis testing aims to determine whether the PBL model influences substances and its Changes topics in the experimental class and replication class given on student learning outcomes. Hypothesis testing in both the experimental class, replication 1 and replication 2 can be seen in Table 4.

Table 4. Hypothesis Testing Results

Class	t-count	t-table	Status
Experimental	5.404	2.056	Ha accepted
Replication 1	6.006	2.037	Ha accepted
Replication 2	5.199	2.064	Ha accepted

Based on Table 4, the hypothesis test calculations show that for the experimental class,

the t-count was 5.404. For replication 1, the t-count was 6.006, and replication 2 got a t-count of 5.199, with the t-table for the experimental class being 2.056, replication 1 being 2.037, and replication 2, being 2.064. So, it can be concluded, based on hypothesis testing in the experimental class, replication 1 and replication 2, that t-count is more prominent or greater than the t-table for the α= 0.05 level. Ha is accepted, and Ho is rejected. This can be seen from the good post-test results from the three classes, where there is an increase in the average value of student learning outcomes from the pre-test scores.

The results show that the average value of student learning outcomes is greater than or equal to the criterion value for achieving learning objectives of 70. In conclusion, the PBL model, through a differentiated approach, affects student learning outcomes. Calculating the average learning outcomes proves that the PBL model influences a differentiated approach to student learning outcomes in substance and its changes topics. This is in line with research by Sari et al. (2023) that after being treated with pretest and posttest results in each class, the results were different. So, it was concluded that there was a difference between before and after receiving treatment. Through the PBL model with a differentiated approach, learning will be more effective because this learning can accommodate students' learning needs. Based on the opinion of Yuli et al. (2021), through the PBL model, students can be invited to work together in study groups divided by the teacher based on the student's learning styles. This learning can develop critical thinking skills and teach students how to collaborate with other students (Fanani et al., 2024).

Observation of Learning Implementation

Based on the data from the calculation of student learning outcomes above, student learning outcomes increase after treatment using the PBL model through a differentiated approach. This is supported by the implementation of learning by observers or teachers who support science subjects in class VII. The following are the results of observations of learning implementation using the PBL model through a differentiated approach in each class, both experimental class, replication 1, and replication 2, which can be seen in graphical form in Figure 6.

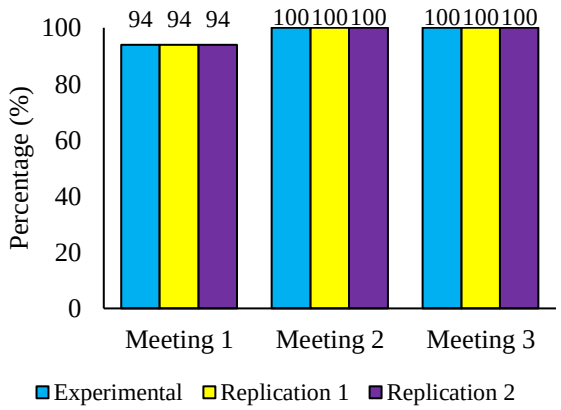

Figure 6. Learning Implementation

Based on Figure 6, the percentage results of observations of implementing the PBL model using a differentiated approach show that implementing learning at meetings 2 and 3 is better than meeting 1. This can be seen from the large percentage at meeting 2 and meeting 3, which shows that it is higher than meeting 1. Percentage results show that implementing the PBL model through a differentiated approach has a very good category in the learning process. There was one stage that was not implemented at meeting 1 in each class, both experimental class, replication 1 and replication 2, namely at the problem orientation stage where the role of students in the learning process was still lacking, namely only a few students showed activeness when giving opinions and asking questions. According to Asmida et al. (2024), teachers are expected to be able to plan and present PBL material, which can increase students' interest and encourage students' curiosity in problem-oriented learning by formulating problems relevant to everyday life.

CONCLUSION

The results of research that has been carried out using experimental research methods, consisting of experimental classes, replication 1 and replication 2, show that the PBL model through a differentiated approach to substance and its changes topics can affect improving student learning outcomes. This is demonstrated by the results of the hypothesis test where the t-count in the experimental class was 5.404 compared to a t-table of 2.056; replication 1 obtained a t-count of 6.006 with a t-table of 2.037; and replication 2 obtained a t-count of

5.199 with a t-table of 2.064. It can be concluded that hypothesis testing in the three classes is t-count greater than t-table. Through a differentiated approach, the PBL model affects student learning outcomes.

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