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The Influence of PBL Model on Student Learning Outcomes in the Form Changes Concept of Substances

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Abstract: The problem-based learning (PBL) model is the learning model that prepares students to think critically and analytically. This study investigates the effect of the PBL model on students' academic performance related to the form changes concept of substances. The research adopts an experimental approach, utilizing a one-group pretest-posttest design. Data for the study was collected through tests and analyzed using descriptive and inferential statistics, including normality tests, hypothesis tests, and n-gain analysis. The result of the research for the experimental class had an average score of 85.29, replication 1 scored 84.71, and replication 2 scored 82.56. Additionally, the average normalized gain was 0.72 for the experimental class, 0.73 for replication class 1, and 0.69 for replication class 2, which means that the Replication 1 sample class was higher, while the experimental and control classes were currently in the category. Thus, the PBL model affects student learning outcomes by changing the concept of substances. The research of the PBL model on student learning outcomes is expected to be developed in other material concepts.

Keywords: PBL Model; Substances; Student Learning Outcomes.

Introduction

Education is a deliberate and organized endeavor to create an environment and learning process that enables students to develop their potential actively in mastery, morals, intelligence, noble character, and competence. In this way, education can be carried out democratically, fairly, and non-discriminatorily as a central means of human resource development [1-2]. The quality of Indonesian citizens is achieved through the delivery of high-quality education. Therefore, teachers have an essential function, role, and position. Thus, teachers need to hone their skills continuously. Teachers must have professional standards in mastering learning materials and strategies and be able to encourage serious learning in their students [3].

Natural science is a field that systematically explores the natural world. Consequently, science is more than just a collection of knowledge consisting of facts, concepts, and principles. According to the Ministry of National Education 2019, Science education aims to "know" and "do" the natural world around us so that we can gain a deeper understanding [4]. Scientific learning integrates the experience of the scientific process with the understanding of scientific outcomes through direct experience. It should be focused on a problem-solving approach that supports human survival within a beneficial cultural atmosphere. In this case, students seek hands-on experiences to help them plan their future lives and survive as tech-savvy and environmentally conscious people. Therefore, scientific learning must be able to develop these two aspects. Science includes scientists' skills and attitudes to achieve scientific results. In other words, developing this process capability can encourage a scientific attitude towards achieving scientific results [5-6].

The view that "Seeing the vision and mission of Indonesian education in the future to produce competitive and quality human resources in various fields of life, the concept of self-directed learning can be accepted" [7]. An independent syllabus enables students to engage in critical, high-quality, expressive, applicable, diverse, and progressive learning. This approach is designed to help students develop according to their potential and abilities. This new curriculum change, cooperation, strong commitment, seriousness, and practical implementation are needed from all parties so that the Pancasila student profile sticks with students [8].

The teacher can foster students' critical thinking skills in physics by choosing an appropriate learning model. The learning model you select requires a student-centered learning syntax. The problem-based learning (PBL) model is the learning model with these characteristics [9-10]. According to Amir (2016), the PBL model prepares students to think critically and analytically [11]. The principle of PBL model learning is that problems are provided as an initial step in the learning process. The issues presented are commonplace in everyday life, and their impact on improving learning outcomes is even more significant [12-14]. The role of educators here is to act as facilitators, guiding students in searching for and finding the solutions they need. Furthermore, according to Rusman (2018), PBL enhances lifelong learning skills by fostering an open, reflective, critical, and active learning mindset [15]. This research is expected to determine the influence of the PBL model on student learning outcomes.

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Research Methods

This study employs an experimental method, explicitly utilizing a group pretest-posttest design on the research flowchart in Figure 1. This design was chosen because there was an initial test before and after treatment. The treatment results can be known accurately with the research design because the effect can be seen, and the research sample consists of an experimental class and two replication classes.

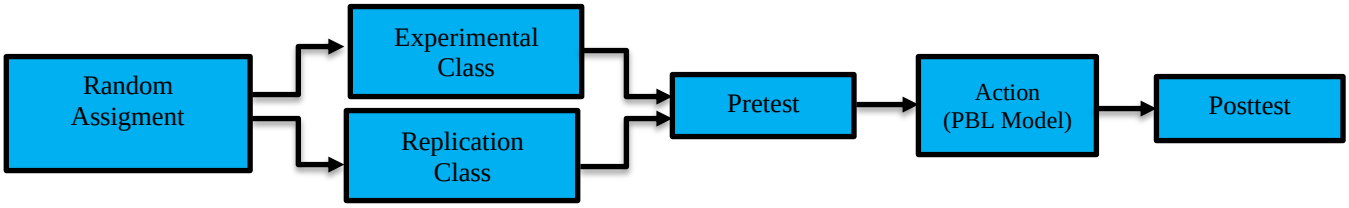

Figure 1. The research flowchart

Information for O_1 is the Test given before the PBL model, X is Treatment in class using the PBL model, and O_2 is the Test given after using the PBL model in Table 1 [16].

Table 1. Research Design

Class	Pretest	Treatment	Post-test
Experiment	O_1	X	O_2
Replication 1	O_1	X	O_2
Replication 2	O_1	X	O_2

This research has three classes: experimental class, replication 1, and replication 2. Replication in an experiment is repeating an experiment under the same conditions. Therefore, the treatment given to the experimental class was the same as the replication class. Tests are given before and after treatment. The material chosen is the concept of form changes of substances. The test consists of 10 questions and includes concepts on the form changes of substances. Meanwhile, learning activities were carried out over five meetings. In the learning activities, treatment is given using the PBL model in the experimental and replication classes.

Results and Discussion

This study was conducted at SMP Negeri 1 Paguyaman Pantai, on Jalan Trans Sulawesi in Paguyaman District, Boalemo Regency. In this lesson, students are expected to grasp the concept regarding the form changes of substances. This is intended to ensure that students consistently comprehend the teacher's material. Student learning outcome scores were obtained from an instrument in the form of an essay description with a total of 10 items, where the test itself is research data in the form of a pretest-posttest conducted in the experimental class, replication 1 and replication 2.

This learning outcomes test aims to determine the success of learning in the experimental class, replication 1 and replication 2, and the effect of the PBL model implemented in the odd semester of the 2023/2024 academic year. Data was obtained after students were given treatment using the PBL model. Then, the researcher analyzed the data using theoretical statistical techniques to obtain several conclusions supporting the research hypothesis. The following will describe student learning outcomes (SLO) and data analysis results in the form of normality tests, hypothesis tests, and n-gain tests.

Description of SLO

Researchers used the calculated average of learning outcomes for each sample group. The results of calculating the SLO average value can be seen in Table 2.

Table 2. Calculation Results

Class	Average	
	Pretest	Posttest
Experiment	45.70	85.29
Replication 1	42.65	84.71
Replication 2	45.17	82.56

Table 2 shows the differences between the experimental classes, replication 1 and replication 2. The average learning outcomes for both experimental and replication classes in the post-test exceed the average pretest scores for more complete results of the average calculation.

Students' cognitive domain learning outcomes according to specific question indicators and cognitive levels. The average achievement from cognitive levels C2 to C5 in the experiment class is illustrated in Figure 2.

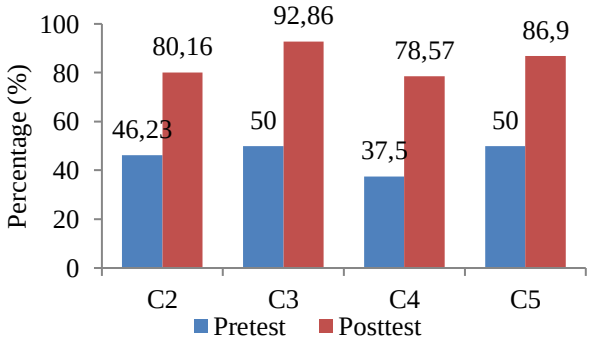

Figure 2. Cognitive domain in experimental

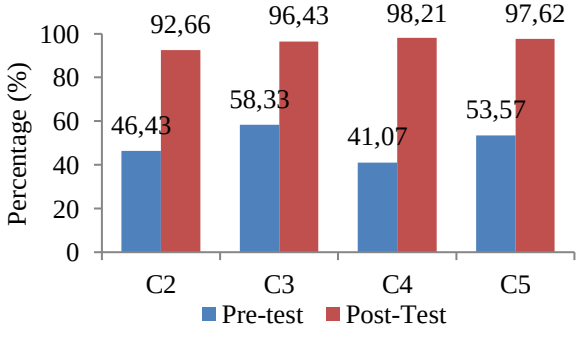

Figure 3. Cognitive Achievement in Replication 1

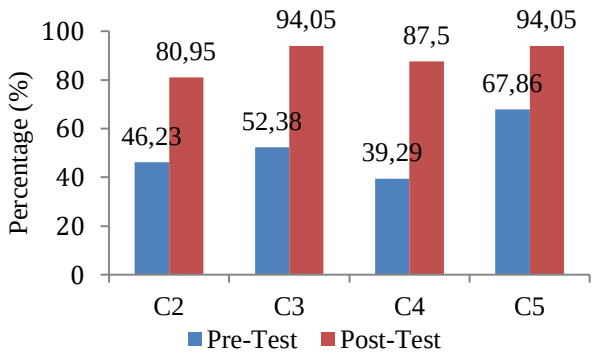

Figure 4. Percentage of cognitive achievement for Replication 2

Figure 2 states that the experimental class's highest average cognitive level score is C3, with a pretest score of 50 and a post-test score of 92.86. This provides information that students understand learning better through an application [17-18]. Based on Figure 3, the cognitive domain achievement in replication 1 is C4, with a pretest score of 41.07 and a post-test score of 98.21. It provides information that students understand learning better through analysis. The post-test scores for each cognitive domain exceed the Criteria for Achieving Learning Goals (CALG) [19-20]. Meanwhile, Replication 2 is C5, with a pretest score of 67.86 and a post-test score of 94.05. It shows provides information that students understand learning better through an evaluation [19-21]. Each cognitive domain percentage is in the form of C2 (Understanding), C3 (Applying, C4 (Analyzing) and C5 (Evaluating). Each cognitive domain of post-test administration exceeds the CALG.

Data Analysis

1) N-gain analysis

Table 3. Test results of n-gain

Class	N-gain	Criteria
Experiment	0.72	High
Replication 1	0.73	Medium
Replication 2	0.69	Medium

Table 3 shows that both the experimental and replication classes fall into the high and medium criteria. Single Student Normalized Gain for the experimental class in Figure 5.

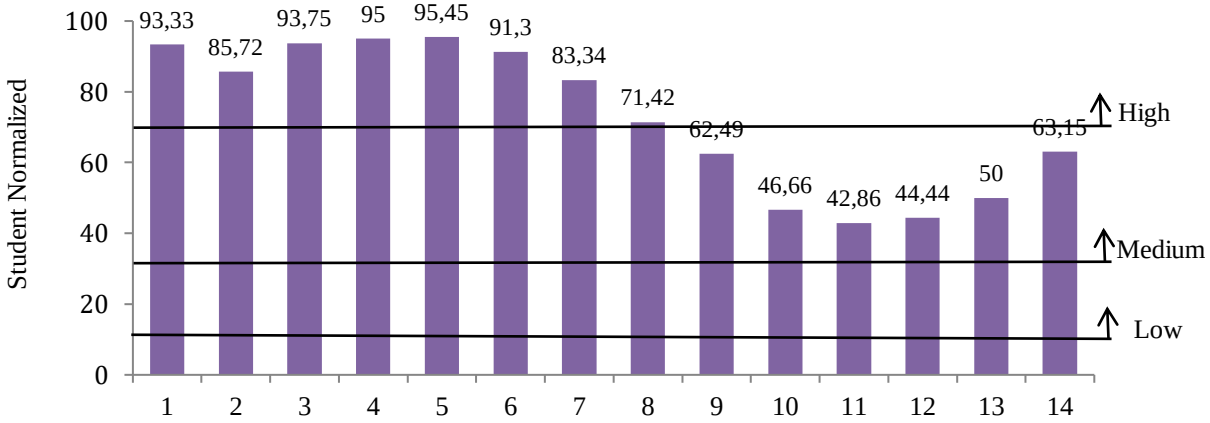

Figure 5. Single Student normalized gain graph for experimental class

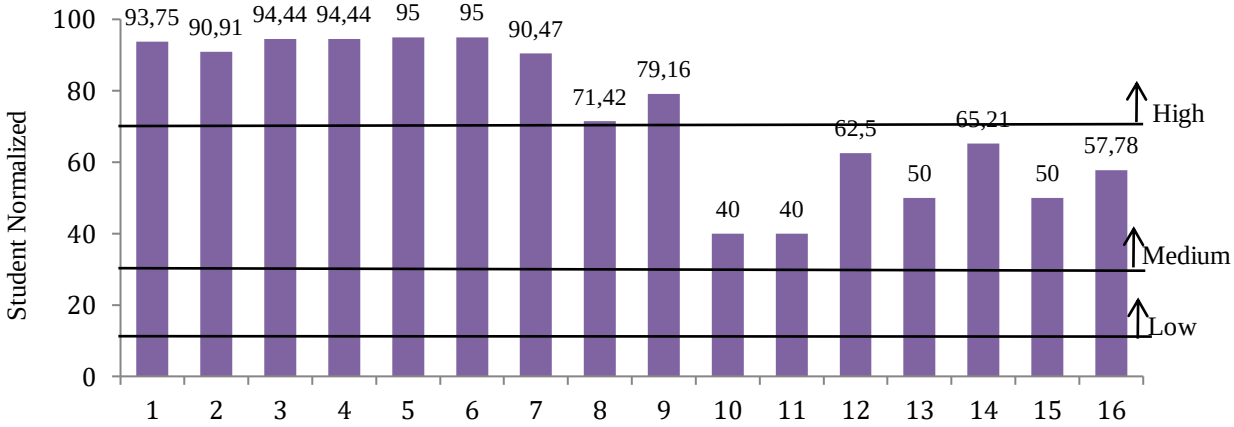

Figure 6. Single student normalized gain for replication 1

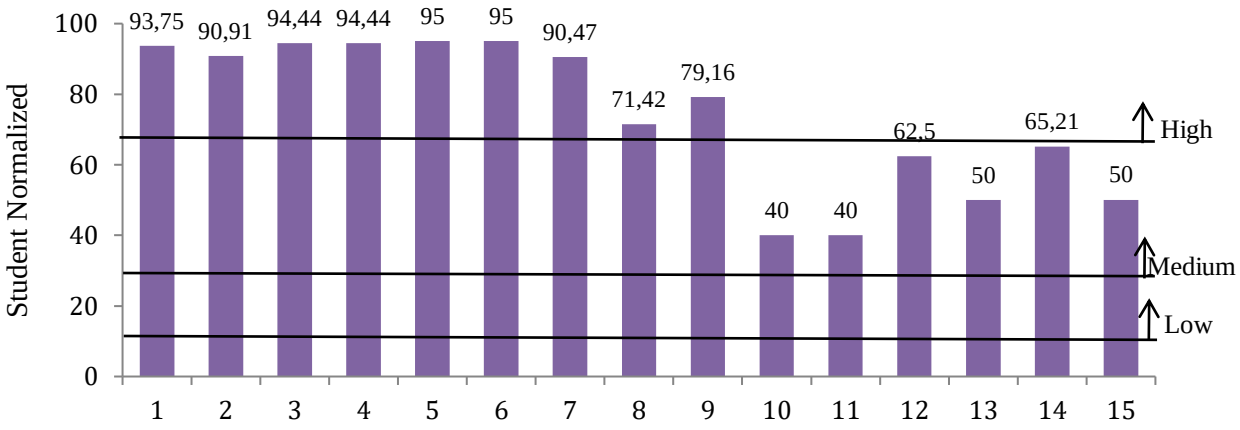

Figure 7. Single student normalized gain for replication 2

Figure 4 shows an increase in understanding for each student in the experimental class by being in the medium and high categories. Then, the Single Student normalized gain in replication 1 can be seen in Figure 6. It shows that there has been an increase in the understanding of each student in replication 1 by being in the medium and high categories, and the single student normalized gain in replication 2 can be seen in Figure 7. It shows that there has been an increase in understanding, which can be seen in every student in replication 2 who is in the medium and high categories. Based on the single-student normalized gain graph in each class, the experimental and replication classes 1 and 2 show no students in the low category [21][22]. Single student normalized gain calculation for each student in both experimental classes, replication 1 and replication 2.

2) Normality test

The data normality test aims to determine if the data is normally distributed. In this research, the Smirnov colmogrof normality test formula contained in Chapter III was used using Microsoft Excel. To test the normality of data in the 3 classes, namely experiment, replication 1, and replication 2, the results obtained from statistical tests can be seen in Table 4.

Table 4. Data Normality Test Results

Class	F_i	K	Status
Experiment	0.457	0.349	Normally distributed
Replication 1	0.462	0.327	Normally distributed
Replication 2	0.459	0.338	Normally distributed

Based on the data normality test results in Table 3, it is known that $Fi \geq K$ for the actual level $\alpha = 0.05$. So, it can be concluded that the research data for the experimental class, replication 1 and replication 2, are normally distributed. Research on the influence of the PBL model on SLO is similar to previous research in that each class is normally distributed if the value is more significant than α =0.05 [17][23]. The PBL model has influences on SLO.

3) Hypothesis testing

PBL model influences the form changes concept of substances in the experimental and replication class given on SLO. Hypothesis testing can be seen in Table 5.

Table 5. Hypothesis testing results

Class	T_{count}	T_{table}	Status
Experiment	9.761	2.178	Ha Accepted
Replication 1	8.269	2.144	Ha Accepted
Replication 2	7.692	2.160	Ha Accepted

Table 4 shows that the Tcount for the experimental was 9.761. For replication 1, it was 8.269, and for replication 2 was 7.692. Meanwhile, T_{table} for the experimental was 2.178, replication 1 was 2.144, and replication 2 was 2.160. The three classes obtained the T_{count} value higher than the T_{table} value with H_a received status [24][25]. The PBL model influences SLO through changes in the concept of substances.

Discussion

The research was carried out using the PBL model, which is more significant than the Minimum Completeness Criteria on the form changes concept of substances in class VII, carried out at SMP Negeri 1 Paguyaman Pantai. This research took class VII as the subject population. The sample consisted of 3 classes, namely class VII C as the experimental class, class VII B as replication class 1, and class VII A as replication class 2, for the use of replication classes in experimental research where the replication itself is repetition of the experiment, to produce better estimates and see the consistency of the results obtained [26]. This research aims to determine the influence of the PBL model on SLO. The advantages of the PBL model are increasing student motivation to learn, improving student problem-solving skills, and promoting student cooperation in group work. This research significantly contributes to various learning systems because it helps in teaching and enables teaching and learning activities. This learning model creates an atmosphere that is not monotonous, and students appear active in the learning process. This research also encourages students to always apply values in learning.

The learning process lasted for five meetings. The first meeting provided a pretest, and the second meeting provided the form changes concept of substances and divided the groups to create their groups and students to observe the learning videos displayed by the teacher. In the third meeting, students experimented with the sub-material of physical and chemical changes in form by burning paper. In the fourth meeting, students carried out a practicum regarding the sub-material of filtering salt water by pouring

salt water into a tablespoon and heating it with a candle. At the fifth meeting, students worked on the post-test the teacher gave as the final test of SLO.

The PBL model increases student interest in learning, which can be seen from students' focus on the learning process, influencing SLO. Apart from that, with this model, the learning process will feel more meaningful but can give a deep impression to students because learning feels more fun and not monotonous, so students are more active in learning. With the PBL model, students can always solve learning problems in everyday life. The PBL model emphasizes student-satisfied teaching through problem-solving on assignments.

PBL is a learning model focusing on students' creativity and meaningful needs. They then create by utilizing their experience and abilities to carry out activities and produce work that they consider useful for themselves or others [27]. The PBL model enables teachers to manage classroom learning by incorporating project work. Students' creativity and motivation increase through learning project work, and they become independent in completing their tasks [28]. The PBL model has influenced SLO through changes in the concept of substances.

Conclusion

The SLO for Class VII in the form changes concept of substances in the PBL model is more significant than the Minimum Completeness Criteria. The course average normalized gain shows this for all sample classes, both experimental and replication classes, which are in the medium and high categories. The experimental class is 0.72, the replication class 1 is 0.73, and the replication class 2 is 0.69. This shows that the PBL model statistically affects SLO by changing the concept of substances.

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