The Effect of Problem Based Learning with Argumentation (PBLA) Model on Argumentation Skills of High School Students on Temperature and Heat Material

D Nurmawan*, T N Ain dan A Rohman
Study Program Physics Education, STKIP Al Hikmah Surabaya
*Email : dnurmawan4@gmail.com

Abstract. Communication is one of the skills of the 4C component which is a 21st century science learning trend and is closely related to argumentation skills. This study aims to describe the effect of Problem Based Learning with Argumentation (PBLA) model on argumentation skills of high school students on temperature and heat material. This research uses quantitative methods. This type of research is a quasi-experiment with the research design used is one group pretest-posttest design with replication class. The results showed that there was an increase in students' argumentation skills with the average N-Gain score of each class being 0.33 and 0.34 in the moderate category. The results of the paired sample t-test test in each class obtained the same significance value (P) of 0.00 (P <0.05). The results of the independent sample t-test test obtained a significance value (P) of 0.722 (P>0.05). Based on some of these criteria, it can be concluded that the results of this study indicate that there is a significant and consistent effect of the Problem Based Learning with Argumentation (PBLA) model on the argumentation skills of high school students on temperature and heat material.

1. Introduction

The 21st century science learning trend is ideally directed at the four 4C components, namely: communication, collaboration, critical thinking & problem solving, creativity & innovation [1]. This requires the role of teachers as educators to develop skills, especially soft skills in students in learning at school so that they are ready to enter the world of work and are able to compete with other countries [2].

Physics as one of the branches of science provides direct learning experiences for students to understand the surrounding nature scientifically. In addition, physics is also not only a collection of knowledge in the form of facts, concepts, or principles [3]. According to Handayani, active students will have an understanding of concepts and reasoning that can be seen from the form of argumentation both in writing and orally [4]. This is certainly in line with the scientific approach that exists in the 2013 curriculum learning. Students are allowed to find evidence and reasons for what they learn.

One of the skills that are relevant to educational goals in this case the scientific process and student reasoning is argumentation skills [5]. Argumentation skills are a person's capacity to be able to influence others with an opinion accompanied by evidence in the form of facts so as to be able to convince that what is expressed is the truth. According to McNeill, argumentation skills themselves are skills in conveying a statement accompanied by reasons in which there are three aspects including claims, evidence, and reasoning [6]. Meanwhile, the aspects of argumentation developed by philosopher Stephen E. Toulmin are divided into six components, namely: claims, data, justification, qualification, refutation, and support [7]. In Toulmin's method, every argument starts with three fundamental parts: claim, data, and justification. These three fundamental aspects will be the focus of this research.

Based on the results of the needs analysis of several students in one of the private high schools in Surabaya city, information was obtained that the average score of argumentation skills obtained by students was 36.7 and fell into the low category. On average, students have been able to make claims to a problem, but not maximized in providing data and justification for their argumentation claims. When students are faced with a problem of physics phenomena in everyday life, solving or answering the

problem must be accompanied by supporting data that can justify the student's answer. Claims, data, and justification are elements in the Toulmin Argumentation Pattern (TAP) [8].

One of the things that can be done by teachers to overcome the above problems is by using the Problem Based Learning with Argumentation (PBLA) learning model. If problem-based learning is intervened with elements of argumentation skills, it will form a new model called PBLA. This model is considered to help students in using critical thinking skills, verbal and written communication, working as a group, and improving leadership [8]. The fundamental thing that distinguishes the PBLA model from PBL is that it lies in the problem solving stage which involves building argumentation skills in it.

In its implementation, researchers also involved virtual labs in learning activities. Virtual lab is used as a means to support learning activities with the PBLA model which in this case is used for practicum activities. The advantages of using virtual labs are that they can hone students' abilities and improve students' understanding of concepts in a material, improve data analysis skills, and facilitate experiments because virtual labs are more flexible so that they can be done anywhere and anytime. The use of virtual lab is also very suitable with the selected material, namely temperature and heat. Practical experiments that are difficult to carry out directly can be carried out through virtual labs without reducing the purpose and objectives of the practicum itself.

Temperature and heat material was chosen to be the object of material to be experimented in using the PBLA model to determine its effect on students' argumentation skills. According to Ma'rifah in her research stated that there were 68.57% cases of students who had difficulty in understanding the concept of temperature and heat material [9]. One needs to apply good argumentation skills in understanding the concepts of temperature and heat. This refers to the ability to understand and connect facts and concepts, as well as the ability to make appropriate conclusions. Argumentation skills must be based on scientific thinking and must be supported by empirical evidence [10].

Argumentation skills are one of the skills that students must have in science learning [11]. This is in line with the objectives of the 2013 curriculum which wants to improve the scientific process and student reasoning. Based on the background described above, the researcher aims to get an overview of the Effect of Problem Based Learning with Argumentation (PBLA) Model on Argumentation Skills of High School Students on Temperature and Heat Material. This it is hoped that this research can provide solutions to existing problems.

2. Methods

This research uses a quantitative approach with a quasi-experimental method. The quasi-experimental method is a research method used to measure the effect of a treatment on a group without controlling other variables. This study used the One Group Pretest-Posttest Design with Replication Class design [12]. This research design uses only one group of subjects as a sample, and carries out measurements before and after the treatment is applied. Replication class refers to repeating the same research in a different class. This replication class will serve in strengthening the research results [13].

The subjects of this study were the XI grade students of SMA Muhammadiyah 3 Surabaya. The research was conducted in the odd semester of the 2022/2023 academic year. This research took place at SMA Muhammadiyah 3 Surabaya which is located at Jalan Gadung III No.7, Jagir, Wonokromo District, Surabaya City, East Java Province 60244. There were two classes used for research, namely XI IPA 2 class as the experimental class and XI IPA 3 class as the replication class, each consisting of 22 students.

To determine students' argumentation skills, researchers used the TKA instrument (Argumentation Skills Test) which had been validated by three validators with an average score for content validation of 3.58 and construct validation of 3.67. The test consists of 5 questions with each question consisting of 3 sub questions which are indicators of argumentation skills, namely claims, data, and justification. Then to find out the results of data processing and analysis using the t test using the Paired Sample t Test to determine the significance of the pretest and posttest values of each class and the independent sample t test to find out how consistent the independent variables have been applied between the experimental class and the replication class using the help of the SPSS application.

3. Results and Discussion

The results of the study are in the form of the effect of the virtual lab-based Problem Based Learning with Argumentation (PBLA) model on the argumentation skills of high school students on temperature and heat material. To determine the effect of the PBLA model, data obtained from the assessment of students' argumentation skills test is needed. The results of the students' argumentation skills test obtained several data centering and distribution scores shown in Table 1.

Table 1. Measures of Centering and Spread of Pretest-Posttest Score Data.

Data Centering and Spread	Experimental Class		Replication Class	
	Pretest	***Posttest***	***Pretest***	***Posttest***
Lowest Score	38,00	51,00	22,00	38,00
Highest Score	62,00	78,00	60,00	73,00
Mean	51,45	67,45	38,45	59,72
Median	51,00	70,00	37,00	60,00
Standard Deviation	5,15	8,34	10,21	10,54

A comparison of the mean pretest-posttest scores of students' argumentation skills between the experimental class and the replication class can be seen in Figure 1 below.

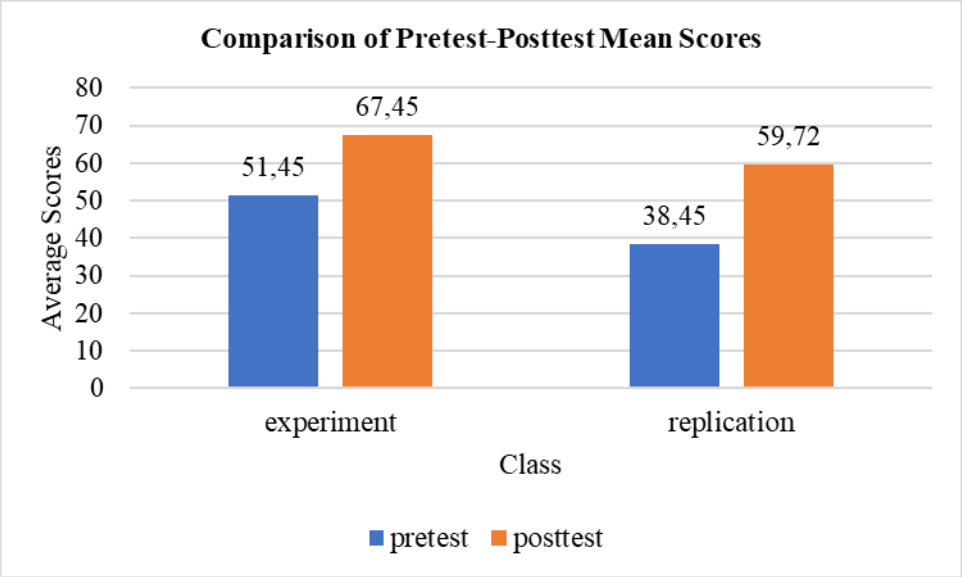

Figure 1. Comparison of Pretest-Posttest Mean Values

Using the N-Gain formula, the level of improvement of students' argumentation skills can be calculated. The N-Gain calculation is based on pretest and posttest data to determine the improvement after treatment [14]. The minimum criteria for test results can be used if at least in the medium category. The results of the N-Gain test in this study are as in Table 2.

Table 2. N-Gain Test Results

No	Class	N-Gain Score	Category
1	Experiment	0,33	Medium
2	Replication	0,34	Medium

Table 2 shows that the experimental class has an N-Gain score of 0.33 and the replication class of 0.34. Both scores fall into the medium category which means that the improvement of argumentation skills in the experimental class or replication class is also medium. The medium criteria for the N-Gain score are in the range of values $0,3 < \bar{x} \leq 0,7$ [15]. A comparison of the average N-Gain scores of the two classes can be seen in Figure 2.

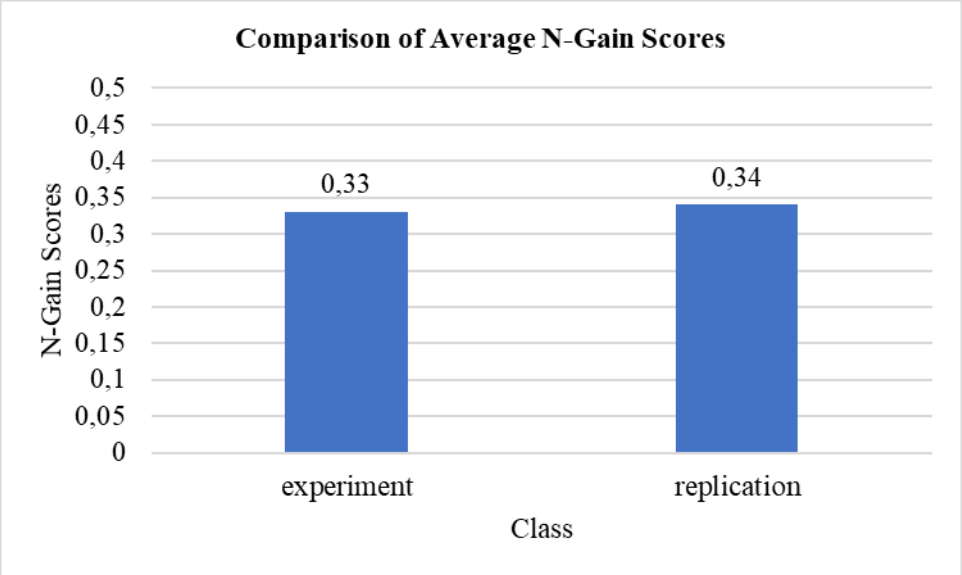

Figure 2. Comparison of Average N-Gain Scores

Claims, data, and justification are elements in the Toulmin Argumentation Pattern (TAP). The average score of the improvement of argumentation skills above when detailed consists of elements of claims, data, and justification, each of which has a score as in Table 3.

Table 3. N-Gain Test of Each Argumentation Skill Indicator

Argumentation Skills Indicator	Experimental Class		Replication Class	
	N-Gain	Category	N-Gain	Category
Claim	0,42	Medium	0,38	Medium
Data	0,34	Medium	0,35	Medium
Justification	0,26	Low	0,26	Low

The N-Gain score for each argumentation skill indicator in each class is shown in Table 3. The claim and data indicators in the experimental class are in the medium category and the justification indicator is in the low category. This is also the case with the score owned by the replication class. There is only a slight difference in score between the two, but still in the same category. A clearer comparison of the N-Gain score for each indicator in each class is shown in Figure 3.

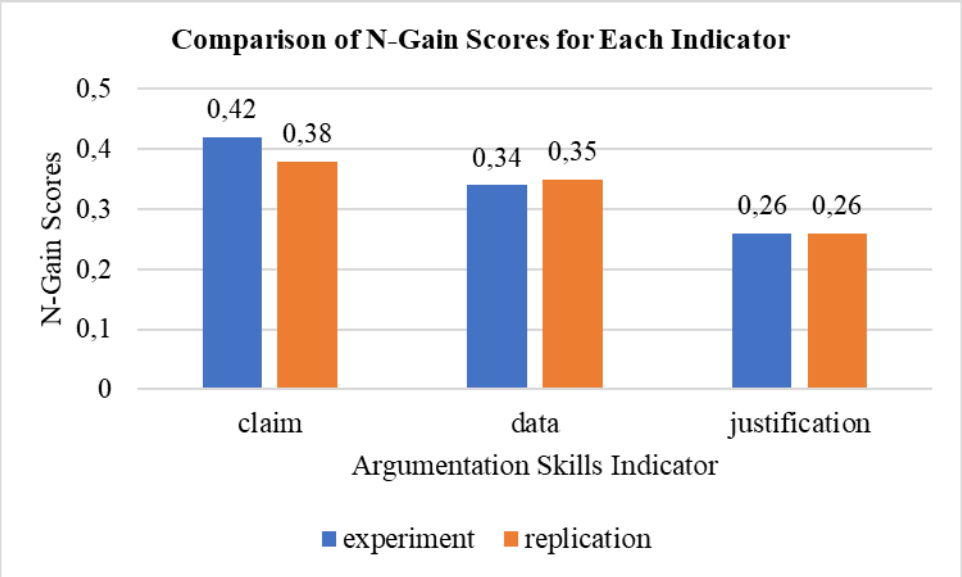

Figure 3. Comparison of N-Gain Scores for Each Indicator

Data from the results of the argumentation skills test are then subjected to prerequisite tests, namely normality and homogeneity tests to determine whether the data is then subjected to parametric or non-parametric analysis. The results of the normality test and homogeneity test can be seen in Table 4 and Table 5.

Table 4. Normality Test Results

No	Class	Sig.	Status
1	Experiment	0,266	Normally Distributed
2	Replication	0,976	Normally Distributed

Table 5. Homogeneity Test Results

Homogeneity Test	Sig.	Status
Pretest-Posttest Based on Mean	0,422	Homogeneous

Based on Table 4, the normality test results show that the data in the experimental class and replication class are normally distributed. This is because the significance value is greater than 0.05. Meanwhile, the results of the test homogeneity test as in Table 5 obtained a data significance value of 0.424. Data is said to be homogeneous if the significance value is > 0.05. Therefore, the data in this study can be said to be homogeneous because the value is greater than 0.05.

After the data has met the requirements of normal distribution and homogeneity, the next stage is parametric testing using the Paired Sample t Test hypothesis test and to determine the significance of the pretest and posttest values of each class and the independent sample t test to find out how consistent the independent variable has been applied between the experimental class and the replication class. The results of the data analysis are as follows:

Table 6. Hypothesis Test Results (Paired Sample t Test)

No	Class		Average	t_{count}	t_{table}	P
1	Experiment	Pretest	51,45	- 9,420	1,717	0,000
		Posttest	67,63			
2	Replication	Pretest	38,45	- 10,693	1,717	0,000
		Posttest	59,72			

Based on table 6, there is a difference in the mean scores of the pretest and posttest in both the experimental class and the replication class, all of which show an increase in the mean score. The results of hypothesis testing using the Paired Sample t Test test show that $t_{count} > t_{table}$ at the 5% significance level and has a P value <0.05, which means that there is a significant increase in the test results of students' argumentation skills in both experimental and replication classes.

Meanwhile, to find out how consistent the virtual lab-based PBLA model has been applied between the experimental class and the replication class, the Independent Sample t Test hypothesis test was used. The results of the Independent Sample t Test hypothesis test are presented in table 7:

Table 7. Hypothesis Test Results (Independent Sample t Test)

No	Class	Average	t_{count}	t_{table}	P
1	Experiment	0,3300	- 0,358	1,717	0,722
2	Replication	0,3455			

Based on table 7 of the hypothesis test results using the Independent Sample t Test test above, the data shows $t_{count} < t_{table}$ which means that there is no significant difference between the results of the argumentation skills test of the experimental class and the replication class. This is also reinforced by the P value which is greater than 0.05. The absence of a significant difference indicates that the virtual lab-based PBLA model is consistent in influencing students' argumentation skills. Consistent means that even when the PBLA model is applied in several different classes, the results still show the same effect.

4. Conclusions

Based on the results of this study, it can be concluded that there is a significant effect of Problem Based Learning with Argumentation (PBLA) model on argumentation skills of high school students on temperature and heat material. Students' argumentation skills are obtained from the process of argumentation building which is a feature of the PBLA model. Students determine claims on a problem based on the data they get. In addition, students are also able to provide a justification that shows the relationship between claims and data. The description of the research results above is based on the percentage of learning implementation which reached 87.5% (very good). The results showed that there was an increase in students' argumentation skills with the average N-Gain score of each class being 0.33 and 0.34 in the moderate category. The paired sample t-test results in each class obtained the same significance value (P) of 0.00 (P<0.05). The independent sample t-test results obtained a significance value (P) of 0.722 (P>0.05). The responses given by students were in the excellent category with an average percentage of 92.5%. The researcher suggested that if a similar study is to be conducted, first test the PBLA model in the experimental class compared to other models in the control class. If it is certain that the influence is caused by the PBLA model, a replication class can be used to find out how consistent the model affects the student argumentation skills variable.

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