



**THE EFFECT OF THE PROBLEM-BASED LEARNING MODEL ON THE
SCIENTIFIC ARGUMENTATION ABILITY OF STUDENTS ON
ENVIRONMENTAL POLLUTION MATERIALS**

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Abstract

The purpose of this study was to determine the effect of implementing the Problem Based Learning (PBL) learning model on the ability of scientific argumentation and how much influence the PBL learning model has on the scientific argumentation ability of students on environmental pollution material in class VII, 1st Junior High School Angkola Muaratais. This study uses a true experiment method with a pretest-posttest control group design. The population in this study were all students of class VII, with two samples, namely the experimental and control classes. There are two samples in this study, namely the experimental class and the control class. The sampling technique used is simple random sampling. Randomly selected samples were from classes VII-A and VII-B. The research instrument used is a scientific argumentation ability test instrument using five essay questions. Analysis of the data used in this study was performed by performing an independent sample t-test and a Cohen's d test. The results of the pretest showed that the initial abilities of students in grades VII-A and VII-B were the same. Class VII-A was chosen as the experimental class, and Class VII-B was chosen as the control class. After that, treatment was given using the PBL learning model in the experimental class and conventional learning using the lecture and question and answer method in the control class. Based on the posttest results, it was found that the PBL learning model had a significant effect on the ability of scientific argumentation on environmental pollution material in class VII 1st Junior High School Angkola Muaratais with a value of $t_{count} > t_{table}$ ($3.828 > 1.684$) using the independent sample t-test test. The influence of the PBL learning model on students' scientific argumentation skills is categorized as strong, with a Cohen's d value of 1.168. It can be concluded that the PBL learning model can have a significant influence on students' scientific argumentation skills and the effect obtained is strong.

Keywords: Problem Based Learning, scientific argumentation skills, environmental pollution

Introduction

Various efforts have been made by the government to meet the challenges of the 21st century era, namely by improving the quality of education in Indonesia through 4C competencies as a skill guide for students. Critical thinking skills have an important role in training students' sensitivity to problems that exist in their surrounding environment. Communication skills are important for students to be able to express the results of their thinking. Therefore, it is important for students to have capabilities that can support critical thinking skills and communicative skills in learning, namely the ability to argue (Devi et al., 2018).

The term "argumentation" in everyday life is different from the term "argumentation" in science education. Scientific argumentation is the ability that is needed by a person to compile an opinion that is supported by evidence and real reasons, with the aim of strengthening his opinion on a matter (Farida & Gusniarti, 2015).

Argumentation is an important activity inherent in the process of scientific exploration (Osborne et al., 2004). Scientific argumentation needs to be applied in science learning, because it can enable students to be directly active in creating various ideas and questions through a series of processes as well as in carrying out scientific practice (Berland & Hammer, 2012). This makes it very important to develop students' scientific argumentation skills in science at school.

The National Science Education Standard (SNPI) emphasizes that scientific argumentation includes several criteria used to measure students' abilities (Diniya et al., 2021). The outcomes of Ambrawati et al. (2021) showed that students' scientific argumentation skills at the junior high school level were only able to write claims (statements), while participants still had difficulty presenting data, warrants (justifications), and supporters because this was the case. Learning in schools has not been able to develop these aspects, and applied learning has not trained argumentation skills well. Other research also proves that most students are only able to provide answers in the form of opinions (claims) to the questions given, but these claims have not been accompanied by scientific evidence to support their opinions. (Handayani et al., 2015).

This is based on a preliminary study that has been carried out at 1st Junior High School Angkola Muaratais, namely by conducting interviews with science teachers. The results of interviews with science teachers

at the school explained that the learning carried out still dominated the lecture and question and answer methods. The teacher explains that in learning that requires in-depth analysis, teachers still find it difficult to apply learning models that can foster students' thinking skills. Students who answer questions given through essay questions are still not fully able to answer questions with confidence. Students cannot write their arguments correctly. The teacher stated that he had never measured the students' scientific argumentation skills in writing using the correct argumentation indicators.

Learning that integrates constructivism learning theory is learner-centered learning. The teacher has a position as an intermediary who has a major role in helping students to actively participate in learning and create meaningful relationships between previous knowledge, new knowledge, and the processes involved in learning. (Sugrah, 2019).

One of the learning models that implements constructivism learning theory is the problem-based learning model, also known as the PBL learning model. The PBL model generally provides flexibility for students to be able to learn actively and continue to find out their own knowledge. Learning activities using the PBL model present problems in a structured and complex manner, where detailed information is not provided to understand all elements of the problem (Riwayani et al., 2019).

The purpose of this study was to determine the effect of the application of the PBL learning model on the ability of scientific argumentation and how much influence the PBL learning model has on the scientific argumentation ability of students on environmental pollution material in class VII, 1st Junior High School, Angkola Muaratais. Therefore, it is very important to know the influence of the PBL model on students' scientific argumentation skills.

Research Method

This research was conducted at 1st Junior High School Angkola Muaratais in the academic year 2021-2022. This research method uses the true experiment method with a pretest-posttest control group design. The population in this study were all seventh-grade students of 1st Junior High School, Angkola Muaratais. There are two samples in this study, namely the experimental class and the control class. The sampling technique in this study used simple random sampling. Randomly selected samples were from classes VII-A and VII-B.

The data collection technique used in this study was to use a test instrument with five essay questions. First, the validity of the instrument is used to measure students' scientific argumentation skills. The validity of the instrument is carried out first. The validity of this instrument was tested using construct validity by giving validity sheets to material experts, lecturers, and learning experts. After the instrument is validated, it is then corrected according to the direction of the validator.

After the instrument is declared valid, the the instrument can be used to achieve the research objectives. A pretest was conducted in classes VII-A and VII-B to see the initial abilities of students. After that, it was compared whether the students' scientific argumentation abilities in the two classes were the same. If the ability is the same, then from the two classes, samples are determined for the experimental and control classes.

The experimental class is given treatment in the form of learning with the PBL model, and the control class is given conventional learning. A posttest was conducted to determine whether there was an effect of the PBL learning model on the students' scientific argumentation abilities after being given treatment. The analysis of the data used in this research is to perform a t test and a Cohen's d test using the SPSS version 28.0 program.

Results and Discussion

Results

This research was conducted in class VII at 1st Junior High School Angkola Muaratais in the even semester of T.A. 2021/2022, whose address is at Sorimanaon Village, Angkola Muaratais District. The population of this study were all students in class VII, amounting to 65 people who were divided into 3 classes. This study has a population of students of class VII with a total of 65 people who are divided into classes. This type of research is a true experiment involving two classes. Class VII-A is an experimental class that is treated using the PBL learning model, while class VII-B is a control class that is treated with conventional learning.

The instrument of students' scientific argumentation skills is validated by a dose of

biology learning experts. The instrument validation on the content aspect is the suitability of the items with the learning objectives, learning indicators, and suitability of the questions with the learning materials. The results of the instrument validation are declared valid and can be used to measure students' scientific argumentation abilities.

1.1 Pretest results of students' scientific argumentation abilities

A pretest was conducted to test the feasibility of the sample and determine the initial ability of students. Testing the results of the pretest using the t-test (independent t-test) with SPSS version 28.0 program. The results of the pretest data processing of students' scientific argumentation abilities can also be seen in Table 1.1.

Table 1.1 Results of independent t-test pretest scientific argumentation ability

Class	N	Me-an	Std. Dev	t	df	Sig. (2-tailed)
Experi-ment	22	39	11,26	-0,86	41	0,39
Control	21	42	11,52			

Based on Table 1.1, it can be seen that the pretest value of students' scientific argumentation skills using the independent t-test test obtained the value of $t_{hitung} = -0.863$. When compared with the value of $t_{table} = 2.021$. So it can be seen that the value of $t_{count} < t_{table} = -0.863 < 2.021$ with the decision that H_0 passes and H_a does not. It can be concluded that students in the experimental class and control class have the same scientific argumentation skills.

1.2. Scientific Argumentation Ability Posttest Results

The final ability test of students (posttest) was conducted to determine the effect of the treatment given to the experimental class sample group. Calculation of posttest results using t-test (independent t-test) with SPSS version 28.0 program. The posttest value of students' scientific argumentation abilities in the

experimental class and control class can be seen in Table 1.2.

Table 1.2. Results of independent t-test posttest scientific argumentation ability

Class	N	Mean	Std. Dev	t	df	Sig. (2-tailed)
Experiment	22	80	9.59	3,82	41	< 0,001
Control	21	59	12.85			

Based on Table 1.2, it could get visible that the calculation in a posttest value of students' scientific argumentation abilities using a t-test obtained the value of $t_{count} = 3.828$. When compared with the grade of $t_{table} = 1.684$. Then it can be seen that the grade of $t_{count} > t_{table} = 3.828 > 1.684$ with the decision H_a is accepted and H_0 is not accepted (rejected). It can be seen that learning using the PBL model can have an effect on students' scientific argumentation abilities more than conventional learning.

Table 1.3. Effect size test results using the Cohen's d formula

Instrument	Standardizer ^a	Point Estimate	95% Confidence Interval	
			Lower	Upper
Scientific argumentation skills	11,299	1,168	0,513	1,811

1.3. Great Test of Treatment Effect

The treatment effect test has the purpose of deciding the influence of the PBL model at students' scientific argumentation abilities. Testing the effect of treatment using Cohen's d formula with the SPSS version 28.0 program. The results of the calculation of the effect size using the Cohen's d test may be visible in Table 1.3.

Based on Table 1.3, it can be seen that the effect size test results obtained a Cohen's d value of 1.168. The values obtained are then interpreted into table 3.6, so the results obtained are Cohen's d values greater than 1.00 ($1.168 > 1.00$). It can be concluded that the PBL learning model has an effect size with a strong category in improving students' scientific argumentation skills in the experimental class.

Discussion

2.1 The Effect of the PBL Learning Model on Students' Scientific Argumentation Ability

The hypothesis tested in this study is that the PBL model affects students' scientific argumentation skills on environmental pollutant materials. The average scientific argumentation ability of students in the experimental class with the PBL model is 71.9, and the average scientific argumentation ability in the control class taught by conventional learning using the lecture method is 58.7.

Based on the results of the independent sample t-test, the hypothesis test obtained the value of $t_{hitung} > t_{table}$ ($3.828 > 1.684$). Based on the t value, it is possible to draw the conclusion that the PBL learning model's implementation has an impact on students' capacity to make scientific arguments about environmental pollution-related topics.

The PBL learning approach has an impact on students' scientific argumentation abilities because of the classroom learning activities. Students have been trained to present their arguments through LKPD in learning activities. This is supported by Kusdiningsih et al. (2016) with research results that student are motivated in learning and capable of understanding scientific concepts. They can carry out argument-based investigations in problem solving and assist students in carrying out essential reasoning from scientific processes, so that it has great potential to improve students' scientific literacy. The worksheets used in this study are based on a PBL learning model that integrates argumentative activities.

There are several steps in the PBL learning paradigm that researchers have employed, including orienting students to

problems; arranging students to learn; leading solitary and group investigations; generating and presenting work; as well as analyzing and evaluating problem-solving processes.

The first phase of the PBL learning model is that researchers orient students to problems. Problems are presented in the form of pictures and narratives that are included in the LKPD. Students feel enthusiastic when problems are presented that are relevant to their lives, so that students are able to build an analysis of the problems and can build higher-order thinking skills (Untari et al., 2018).

Organizing students for learning is the second phase. Researchers help students locate more information about the problems identified during this step, such as looking for factors causing water pollution in student textbooks or other sources of information. Students have a high curiosity for learning because they can discuss and work together to carry out tasks with group members (Nurullita et al., 2021).

The third phase is to guide both independent and group investigations. In this phase, students conduct experiments to test the information that has been collected. Students carry out the experiment by working together to follow the steps that have been prepared in the LKPD. Students are motivated to be able to provide ideas based on facts or knowledge, and students can gain authentic experiences, collect data, collaborate, or discuss with other students, so that students are very enthusiastic and enthusiastic about learning because students can learn while conducting experiments (Tarigan & Diana, 2015).

The process of creating and presenting the work is the fourth phase. Students record their experimental findings in the research results table that is supplied in the LKPD throughout this period. Students have been trained to be able to express their arguments through these questions. So that students become accustomed to writing their arguments in learning activities, the researcher's questions are modified to the indicators of scientific argumentation competence. This is because students, in writing their analysis of experimental results, will trigger students to build their arguments, and students have a curiosity about the truth contained in an

argument and want to get facts that are true and relevant to the results of their experiments (Wibawa et al., 2018).

The analysis and evaluation of the problem-solving process is the final step. Students in this phase are asked to make presentations on the experimental results and answers from each group. Meanwhile, other students (not presenting) were asked to respond and discuss the results of the group that was presenting. This is so that learning in the classroom becomes more active and students are more critical in addressing the challenges provided. Students can express their viewpoints, defend or contradict the opinions of other groups, and do so with genuine examples or facts (Firdausi et al., 2019).

Students' knowledge of the subject is improved by the PBL-based learning paradigm used in the experimental class, enabling them to construct arguments that are supported by evidence and rationale with ease. This is supported by the results of research by Simanjuntak et al. (2020), which states that the application of the PBL learning model can affect students' understanding of concepts in science material, and that students are enthusiastic and active in the learning process.

Understanding the concepts possessed by students is obtained through learning activities that support the development of scientific argumentation skills (Eliana & Setyo, 2020). This is also supported by research by Rahmadani et al. (2020), which states that if students have a good understanding of concepts, they can develop good argumentation skills as well. Through this understanding, students will think logically when writing their arguments.

In the second and third meetings, students were better at writing their arguments. The findings of a study by Dewina et al. (2017), which claim that students have gained experience from the first learning, then the second, and then the third learning in terms of expressing their arguments and already know how to write proper arguments through learning process activities, are also in support of this.

2.2 The Great Influence of the Treatment of the PBL Learning Model on Students' Scientific Argumentation Ability

Based on the results of the independent t-test, which was conducted to examine the effect of the PBL learning model on students'

scientific argumentation skills, the results showed that students in the experimental class had higher scientific argumentation abilities than students in the control class. To find out how much influence the treatment of the PBL learning model had in the experimental class, the researchers conducted a large effect size test, which stated that the PBL learning model had a strong influence in improving students' scientific argumentation skills based on the Cohen's d test with a value of 1.168.

This is because the PBL learning model can help students understand the concepts of subject matter well, have high analytical skills, provide meaningful learning experiences, and be able to build higher-order thinking skills, and be able to solve problems given (Rahman et al, 2020; Suriana et al, 2016; Wela et al, 2020; Asrati et al, 2018).

Based on this explanation, it can be concluded that students who are taught using the PBL learning model have higher argumentation skills than students who are taught using conventional learning. The PBL learning model can affect students' scientific argumentation skills (Junaini et al. 2019; Sarira et al., 2019; Ekanara et al., 2018).

Students who are taught using conventional learning methods are different from students who are taught using PBL-based learning models. During the learning process in the control class, students did not form groups or carry out experimental activities (experiments). Students only listen to explanations about environmental pollution materials, record them in notebooks, and conduct questions and answers with researchers.

The argumentation ability of students in the control class after being given the posttest had an average score of 58.71, which was sufficient criteria. This is because students have not been trained and have not been facilitated to write their arguments during learning activities, so when given a scientific argumentation ability test, students find it difficult to answer questions and their mastery of material concepts is still lacking. Therefore, students in the control class have argumentation skills with sufficient criteria.

Conclusion

Based on the results of research and discussion, conclusions can be drawn as follows.

1. The posttest results obtained stated that the PBL learning model had a significant effect on students' scientific argumentation skills on environmental pollution material in class VII SMP Negeri 1 Angkola Muaratais using the independent sample t-test test with a value of $t_{\text{count}} > t_{\text{table}}$ ($3,828 > 1,684$).
2. According to the Cohen's d test results of 1.168, the PBL learning model treatment used in the experimental class has a substantial impact.

Reference

- Ambarawati. D.S , Muslim, & Hernani. (2021). Analisis kemampuan argumentasi siswa smp pada materi pencemaran lingkungan. *Jurnal Pendidikan IPA*, 10 (1): 13-17.
- Devi, N. D., Susanti, E., & Indriyanti, N. Y. (2018). Analisis kemampuan argumentasi siswa sma pada materi larutan penyangga. *Jurnal Kimia dan Pendidikan Kimia*, 3 (3): 152-159.
- Dewina, S., Ondi S. & Rahma W. (2017). Pengaruh model pembelajaran problem-based learning (pbl) terhadap kemampuan menganalisis dan keterampilan berargumentasi siswa pada konsep pencemaran lingkungan di kelas X. *Quagga*, 9 (2): 54-65.
- Diniya, D., Ilhami A. , Niki D.P., Mahartika, I. & Prakash, O. (2021). Kemampuan argumentasi ilmiah calon guru ipa melalui pendekatan mikir selama pandemi covid-19. *Journal of Natural Science and Integration*, 4 (1): 141-148.
- Diniya, & Rusdiana, D. (2018). Improving students' argumentation by providing analogical mapping-based through lab inquiry for science class. *IOP Conference Series: Materials Science and Engineering*, 288 (1).
- Eliana, D. & Setto A. (2020). Tren pembelajaran argumentasi berbasis toulmin's argument pattern (TAP) dalam meningkatkan kemampuan argumentasi dan pemahaman konsep

- fisika peserta didik. *Inovasi Pendidikan Fisika*, 9 (2): 246-255.
- Ekanara, B., Yusuf, H.A., & Yanti, H. (2018). Hubungan kemampuan penalaran dengan keterampilan argumentasi siswa pada konsep sistem pencernaan melalui PBL (problem-based learning). *Jurnal Biologi dan Pembelajarannya*, 13 (2) : 45-54.
- Erduran, S., Simon., & Osborne, J. (2004). Taping into argumentation: developments in the application of toulmin's argument pattern for studying science discourse. *Science Education*, 88: 915-933.
- Eskin, H., Ogan, B.F. (2013). Argumentation as strategy fpr conceptual learning of dynamics. *Res Sci Edu.* (43): 1939-1956.
- Firdauzi, F.S., Rahma, W. & Handayani. (2019). Penerapan model pembelajaran *problem-based learning* dipadu metode debat terhadap kemampuan berargumentasi. *Jurnal Pendidikan dan Biologi*, 11 (1) : 49-54.
- Handayani, P. (2015). Analisis argumentasi peserta didik kelas X SMA Muhammadiyah 1 Palembang dengan menggunakan model argumentasi toulmin. *Jurnal Inovasi Dan Pembelajaran Fisika*, 2 (1): 60–68.
- Huriah, T. (2018). *Metode student center learning*. Jakarta: Prenamedia Group.
- Junaini, Rusdi, M., & Muslim. (2020). Penerapan model *problem-based learning* untuk meningkatkan kemampuan argumentasi matematika peserta didik kelas X SMAN 2 kota jambi. *Jurnal Pendidikan Matematika*, 4 (1) : 21-31.
- Junaidi, M.R., & Muslim. (2020). Penerapan model *problem-based learning* untuk meningkatkan kemampuan argumentasi matematika peserta didik kelas X sman 2 kota jambi. *Jurnal Pendidikan Matematika*, 4 (1): 21-31.
- Miaturrohmah & Fadly, W. (2020). Looking at a portrait of student argumentation skills on the concept of inheritance. *Integrative Science Education and Teaching Activity Journal*. 1 (1): 17–33.
- Nurullita, Khairuddin & Satwika, T.N. (2021). Peningkatan hasil belajar IPA melalui model *problem-based learning* siswa SMP Muhammadiyah Muntilan. *Jurnal Profesi Kependidikan*, 2 (2) : 137-144.
- Probosari, R. M., Ramli, M., Harlita, H., Indrowati, M., & Sajidan, S. (2016). Profil keterampilan argumentasi ilmiah mahasiswa pendidikan biologi FKIP UNS pada mata kuliah anatomi tumbuhan. *Jurnal Pendidikan Biologi*, 9 (1): 29-33.
- Rahmadhani, K., Desy, F.P., Santosa, S. (2020). Kajian profil indikator kemampuan argumentasi ilmiah pada materi zat aditif dan zat adiktif. *Jurnal Ilmiah Pendidikan IPA*, 7 (1) : 1-9.
- Rahman, A., Khaeruddin & Evi, S. (2020). Pengaruh model PBL terhadap kemampuan berpikir kritis dan pemahaman konsep IPA siswa kelas V SDN 30 Sumpangbita. *Jurnal Edumaspul*, 4 (1) : 30-41.
- Riwayani, R., Riki P., Ratna S., Jumadi J. & Heru K.(2019). Analisis kemampuan argumentasi ilmiah siswa pada materi optik: *Problembased learning* berbantuan edu-media simulation. *Jurnal Inovasi Pendidikan IPA*, 5 (1):45-53.
- Sarira, P.M., Desi, F.P., Susanti, P.A. (2019). Hubungan argumentasi ilmiah dan hasil belajar kognitif pada penerapan model *problem-based learning* (pbl). *Jurnal Pendidikan Sains & Matematika*, 7(2):1-10.
- Simanjuntak, M.P., Marpaung, N., Sinaga, L., & Siregar, N. (2020). The effect of *problem-based learning* based on multiple representations to the students' science conceptual understanding. *Journal of Physics: Conference Series*, 1819(2021) 012029: 1-8.
- Sugrah, N. (2019). Implementasi teori belajar konstruktivisme dalam pembelajaran sains. *Humanika*. 19 (2):121-138.
- Sugiyono. (2019). *Metode penelitian pendidikan: kuantitatif, kualitatif, kombinasi, R&D, dan penelitian pendidikan*. Bandung: Alfabeta.
- Tarigan, E.A. & Diana, R. (2015). Pengaruh metode praktikum berbasis PBL terhadap kemampuan argumentasi tertulis siswa pada materi interaksi

- mahluk hidup dengan lingkungannya. *Edusains*, 7 (2) : 135-142.
- Toulmin, S. (2008). The uses of argument. *International Journal of Science Education*, 34 (130): 244-245.
- Untrari, E., Nikmatul, R. & Wahyu, L. (2018). Model pembelajaran problem based learning (PBL) sebagai pembiasaan higher order thinking skills (HOTS) pada pembelajaran IPA disekolah dasar. Prosiding Seminar Nasional Pendidikan Sains (135-142). Surakarta: Universitas Negeri Malang.
- Wela, G.S., Chandra, S. & Hestiningtyas, Y.P. (2020). PBL dengan pendekatan multiple representation terhadap kemampuan berpikir kritis ditinjau dari kemampuan kolaborasi. *Jurnal Terapan Sains dan Teknologi*, 2 (3) : 209-220).
- Wibawa, R.A.P., Baskoro, A.P. & Marjono. (2018). Penerapan model problem based learning pada materi pencemaran lingkungan untuk meningkatkan kemampuan argumentasi ilmiah tertulis siswa kelas X MIPA. *Jurnal Biogenesis*, 14 (2) : 29-36.
- Widi, M.T., et.al. (2021). Analisis keterampilan argumentasi ilmiah peserta didik pada model pembelajaran berbasis toulmin's argumentation pattern (TAP) dalam memahami konsep fisika dengan metode library research. *Journal of Science Education*, 5(1): 79-91.