JPPIPA 9(2) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Implementation of Argumentation-Based Problem-Based Learning Models to Improve Critical Thinking Skills in Vibration and Wave Material

Ahmad Farisi[1]*, Evendi[1], Abdul Halim[1], Muhammad Syukri[1], Elisa[1]

[1,] Syiah Kuala University, Banda Aceh. Indonesia.

Received: December 24, 2022
Revised: February 13, 2023
Accepted: February 25, 2023
Published: February 28, 2023

Corresponding Author:
Nuranti Anarkhis
ahmadfarisi91@gmail.com

DOI: 10.29303/jppipa.v9i2.2716

Abstract: The demands of 21st-century skills are critical thinking skills and scientific literacy skills. In fact, from the results of observations and interviews conducted at MTsS Nurul Falah school, it was found that students critical thinking skills and scientific literacy skills were still low. The purpose of this study was to analyze students' critical thinking skills. students on vibration and wave material taught by the argumentation-based PBL model at MTsS Nurul Falah. This study uses a quasi-type quantitative approach experiment with the Non-Equivalent Control Group Design research design. The population used in this study were all students of class VIII. And the sample used purposive sampling techniques determined based on initial test scores when students first enter the school. Based on these considerations, class VIII-A with a total of 27 students was selected as the control class and class VIII-C with a total of 26 students was selected as the experimental class. The instrument used in this research is test questions in the form of essays. The research data were analyzed using the average test, N-gain, and independent sample t-test. The results showed that the average critical thinking value of the experimental class was in the high category and the control class was in the medium category. Based on the independent sample t-test, it was found that there was a significant difference in improving students' critical thinking skills and students' scientific literacy abilities on vibration and wave material taught using the argumentation-based PBL model at MTsS Nurul Falah.

Keywords: Argumentation-based PBL; Critical Thinking Skills; Vibration and Wave Material

Introduction

The main topic in education today, both in developed and developing countries, is preparing students to face the challenges of the industrial revolution 4.0 in the 21st century (Kardoyo et al, 2020). 21st-century education focuses on a humanistic and democratic learning approach with the aim of achieving their highest potential, finding their identity and purpose in life, and becoming more socially and environmentally responsible (Parizek, 2021). According to Viennot and Décamp (2018); Sholihah (2020) and Kardoyo et al (2020), most educators agree that learning Critical Thinking Skills (CBC) is one of the goals of current education.

Based on the results of observations at MTs.S Nurul Falah Meulaboh, researchers found that science teachers often apply a teacher-centered approach. Causing a very passive class atmosphere, because the learning center is not on the students. What should be more active is that students and teachers help facilitate their learning needs (Simatupang, 2019:13). Based on the results of interviews with students, it was found that teachers rarely invite students to carry out scientific investigations. In addition, they thought that physics material (integrated science group) was very difficult to understand and some felt that it was not too important to study physics. The opinion of teachers, often use student-centered learning models. But experienced several obstacles, so it is not optimal in its actions. Constraints that are often faced by teachers include taking a long time to prepare classes, lack of knowledge about learning models, teaching hours, and the teacher's lack of understanding about how to measure CBC.

CBC and scientific literacy can be trained using strategies, approaches, and method techniques that involve students actively in learning (Fadilla, 2021; Kusumastuti et al, 2019). One of them is by using Problem-Based Learning (PBL) or problem-based learning. Several researchers have reported that one of

How to Cite:
Farisi, A., Evendi, E., Halim, A., Syukri, M., & Elisa, E. (2023). Implementation of Argumentation-Based Problem-Based Learning Models to Improve Critical Thinking Skills in Vibration and Wave Material. *Jurnal Penelitian Pendidikan IPA*, *9*(2), 609–612. https://doi.org/10.29303/jppipa.v9i2.2716

the advantages of the PBL model is that it can increase the CBC (Rehmat and Hartley, 2020; Amin et al, 2020; Seibert, 2021; Maulidiya and Nurlaelah, 2019; Parno et al, 2019; Yuliati et al, 2018). In addition, PBL can also be used to improve scientific literacy skills (Nurtanto et al., 2018; Amaringga et al., 2021; Nainggolan, 2021; Prastika et al., 2019; Qomariyah, et al., 2019).

The PBL model is a learning model that carries out the learning process by making the problem the central point of learning. PBL was chosen for three reasons: (1) this learning model is student-centered and able to involve students comprehensively in building new knowledge through investigation and problem-solving (Choden & Kijkuakul, 2020; Akben, 2019; Ulger, 2018), (2) can change students' perceptions of learning concepts and can encourage changes in learning styles (Steck et al. 2012), (3) PBL can be adapted to various classroom settings (Cullen & Jackson, 2018; Akben, 2019).

Several reports indicate that the PBL model alone is not enough to achieve the objectives of student investigations, because the solution found has no justification or false claims, it requires argumentation skills to support the validation of a claim (Choden and Kijkuakul, 2020). Akhdinirwanto et al (2020) argue that, PBL alone is not effective in increasing understanding of basic concepts, causing difficulties in arguing and can have implications for students' KBK abilities. These deficiencies can be overcome by entering arguments into PBL. This skill can facilitate students in supporting communication and collaboration skills in the field of science (Diniya et al, 2021). Through it, they can exchange opinions (scientific discussion) to find evidence-based solutions to a problem.

One of the physics materials that are often encountered in everyday life is vibration and wave matter. But this material is still considered difficult by some people. As Ummah et al (2019) found, students experience difficulties associating the concept of light waves with their daily lives. The Observation Report of Harum et al (2020) shows that students still do not understand physics concepts, especially in mechanical waves based on midterm exam data. This condition is also experienced at MTs.S Nurul Falah in the 2020/2021 academic year.Of the 32 students, only 3 of them were able to achieve a score of 75 from the established Minimum Completeness Criteria (KKM). Of course, this material is the basis for understanding wave material at a higher level such as optical, mechanical, and other waves.

Method

The research approach used is quantitative research with a quasi-experimental type. The reason for choosing this type is that researchers cannot exercise full control over variables from outside influences. So the condition of the variables at the time of conducting the investigation is in a natural state. As for the design using a Nonequivalent Control Group (table 1). In this design, the experimental group and the control group were not randomly selected (Sugiyono, 2003).

Table 1. Nonequivalent control group research design

Nonequivalent Control Group Design		
O1	X1	O2
O1	X2	O2

(Source: Fraenkel et al, 2012)

Information:

O1 : pretest control class and experimental class

O2 : posttest control class and experimental class

X1 : Treatment in the experimental class using the argumentation-based PBL model

X_2 : Treatment in the control class using the PBL model

The population in this study were all students of class VIII MTs.S Nurul Falah who were grouped into 4 classes by number113 students. To determine the sample, researchers used a purposive sampling technique determined based on initial test scores when students first enter the school. Based on these considerations, class VIII-A with a total of 27 students was selected as the control class and class VIII-C with a total of 26 students was selected as the experimental class. The instruments used in this research are the Learning Implementation Plan, Student Worksheets, Argumentation Sheets, and KBK test sheets.

Result and Discussion

Critical thinking skills in this study all the data obtained was measured using questions that passed the due diligence test as many as 5 pieces in the form of descriptions, where the questions used were analyzed using Microsoft Excel to see the average value obtained related to pretest and posttest data and N-gain on skills students' critical thinking. Questions related to critical thinking skills were given to students twice, the first during the pretest and the second during the posttest.

Based on the results of the study, it was found that the posttest mean score for the experimental class was higher than that for the control class and there was an increase in students' critical thinking skills as seen from the N-gain scores in the experimental class and the control class. The results obtained from the research analysis related to improving students' critical thinking skills can be seen briefly in Table 2

Table 2. Improvement of Critical Thinking Skills in the Experiment and Control Class

Class	The Average Value of Students' Critical Thinking Skills		*N-gain*	Category
	Pretest	Posttest		
Experiment	33	86	0.79	Tall
Control	32	69	0.54	Currently

Source: MTsS Nurul Falah, 2022 (data processed)

The results of students' critical thinking skills as seen from the pretest and posttest scores as well as the N-gain scores in Table 4.1 above show that the pretest scores for the two classes are relatively the same and are still very low. This shows that students' understanding of vibration and wave material is still very low. , where for the experimental class the pretest value obtained was 33 and for the control class it was 32, while for the posttest average value obtained in the experimental class was 86 which was greater than the control class which was only 69. These results indicate an increase in students' critical thinking skills to vibrations and waves.

The magnitude of the average value obtained in the experimental class is because in that class learning is carried out by applying the Argumentation-based PBL learning model as an alternative learning, while in the control class using PBL learning. In the learning process, both classes carried out experiments with different treatments in order to strengthen students' understanding of the concept of vibration and waves so that it would affect their learning outcomes.

Critical Thinking Skills Difference Test

Hypothesis testing can be known by conducting a t-test so that the results of the truth or not testing the hypothesis can be seen. The results are presented in Table 3.

Table 3 Test the difference in critical thinking skills

Class	Normality		Homogeneity	t-test		Conclusion
	Pretest	posttest		tcount	Ttable	
Control	0.669	0.555	0.790	12.230	2.042	There are differences in critical thinking skills
Experiment	0.230	0.958				

Source: MTsS Nurul Falah, 2022 (data processed)

Based on the normality and homogeneity tests, it is known that the data on student learning outcomes for the normality test in the control class are 0.669 and 0.555. While in the experimental class 0.230 and 0.958. The homogeneity test of the two classes is 0.790. The values obtained from the two tests for each class are sig > 0.05, so it can be concluded that both data are normally distributed and homogeneous. Based on the normality and homogeneity test results, a t-test can then be carried out to see whether the hypothesis is accepted or rejected. Hypothesis testing was measured using an independent sample test through SPSS version 25 software with a significant value > 0.05. The test results show that posttest scores in both classes obtained tcount (12.230) > ttable (2.042), this indicates that there is a significant difference between the two classes, namely the control and experimental classes. This difference can be seen in the experimental class that applies the Argumentation-based PBL learning model, while the control class applies the PBL learning model.

Conclusion

Based on the results of the study, it can be concluded that there is a significant difference in the improvement of students' critical thinking skills in wave vibration material taught using the argumentation-based PBL model.

References

Akben, N. (2019). Suitability of problem scenarios developed by pre-service teacher candidates for problem-based learning approaches. *Eurasian Journal of Educational Research,* 83: 231-252. Retrieved from https://dergipark.org.tr/en/pub/ejer/issue/50254/648595

Akhdinirwanto, RW, Agustini, R., & Jatmiko, B. (2020). Problem-based learning with argumentation as a hypothetical model to increase the critical thinking skills for junior high school students. *Journal of Indonesian Science Education*, 9 (3): 340-350. Retrieved from https://journal.unnes.ac.id/nju/index.php/jpii/article/view/19282

Amaringga, NG, Amin, M., & Irawati, MH (2021). The effect of a problem-based learning module containing research results to improve students' scientific literacy. *AIP Conference Proceedings*, 2330 (1): 0300521- 0300527. Retrieved from https://aip.scitation.org/doi/abs/10.1063/5.0043529

Amin, S., Utaya, S., Bachri, S., Sumarmi., & Susilo, S. (2020). Effects of problem-based learning on critical thinking skills and environmental attitude. Journal for the Education of the Gifted, 8 (2): 743-755. http://dx.doi.org/10.17478/jegys.650344

Ariyanto, SR, Lestari, IWP, Hasanah, SU, Rahmah, L., & Purwanto, DV (2020). Problem based learning and argumentation as a solution in improving the critical thinking skills of SMK students. Educational Journal: *Journal of Research Results and Literature Review in the Field of Education, Teaching and Learning*, 6 (2): 197-205. Retrieved from https://e-journal.undikma.ac.id/index.php/jurnalkependidikan/article/view/2522

Chen, YC, Benus, MJ, & Hernandez, J. (2019). Managing uncertainty in scientific argumentation. *Journal of Science Education*, 103(5): 1235–1276. Retrieved from https://onlinelibrary.wiley.com/doi/full/10.1002/sce.21527

Choden, T. & Kijkuakul, S. (2020). Blending problem-based learning with scientific argumentation to enhance students' understanding of basic genetics. *International Journal of Instruction,* 13 (1): 445-462. https://doi:10.29333/iji.2020.13129a

Cullen, T. & Jackson, CD (2018). Problem-based learning in the life science classroom, K–12. *Interdisciplinary Journal of Problem-based Learning*, 12 (1). https://doi.org/10.7771/1541-5015.1771

Diniya, D., Ilhami, A., Permana PND, Mahartika, I., & Prakash, O. (2021). Scientific argumentation skills of prospective science teachers through the MIKiR approach during the Covid-19 pandemic. *Journal of Natural Science and Integration*, 4(1): 141-148.

Fadilla, N., Nurlaela, L., Rijanto, T., Ariyanto, SR, Rahmah, L., & Huda, S. 2021. Effects of problem-based learning on critical thinking skills. *Journal of Physics: Conference Series*, 1810: 1-5.

Fettahlıoğl, P. & Aydoğdu, M. (2018). Developing environmentally responsible behaviors through the implementation of argumentation and problem-based learning models. *Research in Science Education*, 50: 987-1025. Retrieved from https://ejournal.umm.ac.id/index.php/jpbi/article/view/15220

Fraenkel, JR, Wallen, NE, & Hyun, HH (2012). How to Design and Evaluate Research in Education 8th Edition. Boston: McGraw-Hill Higher Education.

Galih, ISE, Abdurrahman., & Rosidin, U. (2019). Development of student work sheets based on analogy content in physical learning to improve critical thinking abilities of high school students. *Journal of Science Education*, 20(2): 24-28.

Harum, CL, Yusrizal., Syukri, M., & Nurmaliah, C. (2020). The effect of phet-based generative learning models on critical thinking skills and student motivation in mechanical wave material. *Indonesian Journal of Science Education*, 8 (2): 164-174. Retrieved from https://garuda.kemdikbud.go.id/documents/detail/1749645

Hasnunidah, N., Susilo, H., Irawati, M., & Suwono, H. (2020). The contribution of argumentation and critical thinking skills on students' concept understanding in different learning models. *Journal of University Teaching & Learning Practice*, 17(1):1-11. Retrieved from https://ro.uow.edu.au/jutlp/vol17/iss1/6/

Husnaini, SJ & Chen, S. (2019). Effects of guided inquiry virtual and physical laboratories on conceptual understanding, inquiry performance, scientific inquiry self-efficacy, and enjoyment. Journal of Physical Review Physics Education Research, 15 (1): 0101191- 01011916. Retrieved from https://journals.aps.org/prper/abstract/10.1103/PhysRevPhysEducRes.15.010119

Istiyono, E., Mustakim, SS, Widihastuti., Suranto., & Mukti. 2019. Measurement of physics problem-solving skills in female and male students by physteproSS. *Journal of Indonesian Science Teachers*, 8(2):170-176. Retrieved from https://journal.unnes.ac.id/nju/index.php/jpii/article/view/17640

Ju, H., & Choi, I. (2018). The role of argumentation in hypothetico-deductive reasoning during problem-based learning in medical education: A conceptual framework. Interdisciplinary J. of Problem-based Learning, 12(1): 1-18. https://doi.org/10.7771/1541-5015.1638