The Influence of the Virtual Laboratory Media Problem-Based Learning Model on the Creative Thinking Ability of Middle School Students

Abstract

This research aims to determine the effect of the Problem-Based Learning (PBL) model using virtual laboratory media on students' creative thinking abilities on harmonious vibration material at SMPN 17 Jambi City. The method used in this research is experimental research using a Quasi-Experimental form with a Non-Equivalent Control Group Design research design. In this study, there were two sample classes: class VIII C as the experimental class and class VIII B as the control class. The instruments in this research used essay tests, observation sheets on teacher and student activities in implementing the model, and observation sheets on creative thinking abilities with data analysis techniques, including normality tests and nonparametric tests, namely the Wilcoxon Signed Test and Mann Whitney. The research results show that the Sig. in the nonparametric test is 0.000. Sig. 0.001< 0.05. Based on the research results, the Problem-based Learning (PBL) model, which uses virtual laboratories, significantly affects students' creative thinking abilities. So the use of the Problem-Based Learning (PBL) model using the Virtual Laboratory significantly influences students' creative thinking abilities in harmonious vibration material in class VIII SMPN 17 Jambi City

Keywords: Problem-Based Learning, virtual laboratory media, students' creative thinking abilities.

Introduction

Learning can run optimally when implemented using appropriate learning models, media, and active learning activities. According to Haryanti & Saputra (2019), the measurement of ability after learning science (physics) should be by 21st-century skills, referring to students' skills to think critically, creatively, communicate, and collaborate, or what is known as 4C (critical thinking, creativity, communication, and collaboration). Based on this explanation, creativity is one of the demands students must have in 21st-century skills.

Creative thinking is a process of coming up with new ideas or thoughts in solving problems through the direct participation of students when solving problems so that they will produce ideas or concepts and solutions to these problems (Lee, 2005). Creative thinking answers problems based on existing data/information with various alternative answers. The answers show creative thinking indicators, originality, flexibility, flexibility, and elaboration (Torrance, E, 1968).

Physics is a group of natural sciences that plays a vital role in developing science and technology. Physics has complex concepts requiring high-level thinking skills such as creative thinking. Related to this, science learning needs to be oriented towards process skills. Peter Gega formulated six process skills that are developed in science learning, which in this case are specific to the field of physics: observing, classifying, measuring, communicating, concluding, and planning experiments.

Based on interviews with science teachers at SMPN17 Jambi City, information was obtained that teachers had an initial understanding of creative thinking skills, but this needed to be more profound. Thus, evaluating or measuring students' creative thinking abilities regarding learning outcomes and processes has never been done.

The learning process at the research site still needs to improve students' understanding of science (physics) material. Although learning is expected to focus on students, it tends to be teacher-centered. It is reflected in students' need for more active involvement in learning, where only around 20% of students are actively involved. This condition shows the characteristics of more "teacher-centered" or teacher-oriented learning.

Apart from that, the teacher also said that students had difficulty answering questions that required problem-solving or analysis and relating the lesson material to everyday life. From the analysis of several science educators at SMPN 17 Jambi City, students' thinking abilities in science learning are in the low category (Low Order Thinking). The decline in students' thinking abilities in science learning at SMPN 17 is thought to have occurred due to the COVID-19 pandemic. This pandemic has resulted in gaps in the experience-based learning process, which usually trains students' high-level thinking skills, including creative thinking abilities.

Interviews conducted by researchers at SMPN 17 with several class VII students showed that the students had quite a good interest in learning science (physics). However, the students needed help understanding some of the material. It causes students to tend to feel bored in the learning process, ultimately becoming passive with the main focus on reading, taking notes, and listening. At the same time, science practicums are rarely carried out due to limited equipment and materials. Students also admit that they have difficulty solving questions that require analysis, especially those related to everyday life. As a result, students often rely on friends to help them answer questions given by the teacher.

Based on the explanation above, students' creative thinking abilities must be trained and measured in learning. Therefore, innovation is needed that can help and facilitate students' improvement of their creative thinking abilities, namely by using the Virtual Laboratory Media PBL learning model.

The Problem-based Learning (PBL) model is a learning model that helps students solve problems they face in the learning process. Problem-based learning exposes students to real everyday life problems so that they can develop their knowledge in solving problems, seek various solutions, and encourage students to think creatively Suparman & Husen (2015). It is in line with Iftitahurrahimah et al. (2020), which states that learning using the PBL model can provide students with a more meaningful learning experience because students are directly involved in various stages of learning.

A virtual laboratory is an interactive and complex situation where students solve problems in the form of simulations, individually or in groups (Serungke et al., 2020). Using virtual laboratory media in Physics learning is an alternative learning strategy. The features provided help students make analogies with abstract physics concepts and require mathematical logic to explore their creative abilities (Simanjuntak et al., 2021).

Based on the explanation above, the ability to think creatively in the current technological era is one of the markers of the quality of a country's education. It is even considered a very relevant skill for the future. Using appropriate learning models by optimizing technology is one method for improving the quality of learning. Therefore, the Problem-based Learning model and virtual laboratory can be used as a learning model and media to improve creative thinking abilities. The research aimed to see the effect of implementing the PBL learning model using virtual laboratory media on students' creative thinking abilities.

Method

The type of research used is a Quasi-Experimental approach, which is developing a proper experimental design with a Non-Equivalent Control Group Design research design. The design form used in this research is the Pretest-Posttest Design. This research used two classes: the experimental class, which was given treatment with PBL with virtual laboratory media, and the control class, which was given PBL treatment without virtual laboratory media. The sampling technique in this research is using the Cluster Random Sampling technique. The samples in this study were homogeneous, namely class VIII C as the experimental class with 30 students and VIII B as the control class with 30 students. The data collection techniques used in this research are pretests and posttests for Creative Thinking Ability, non-tests in the form of documentation, observation sheets in the form of Creative Thinking Ability observation sheets, and observation sheets for teacher and student activities.

Results and Discussion

The results of measurements of students' creative thinking abilities, both in the pretest and in the posttest, can be seen in Figure 1 below:

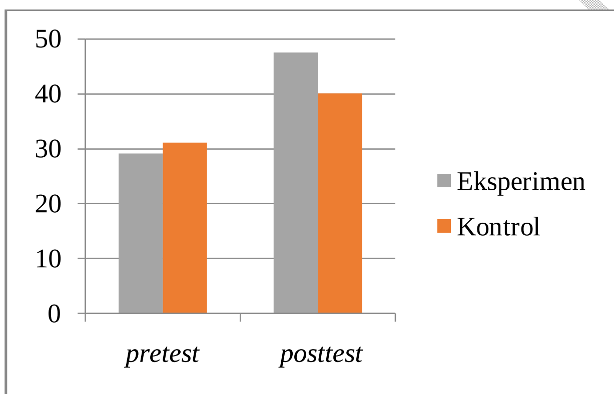

Figure 1. Pretest-Posttest Scores for Experimental and Control Classes

Figure 1 shows that the average pretest results in the control and experimental groups differ by 1.95. This difference indicates that the two groups have almost the same initial abilities. Meanwhile, the posttest difference was quite significant, namely 7.37. This difference also indicates that the two groups have differences in final abilities.

The measurement results for each aspect of creative thinking can be seen as shown in Figure 2 below:

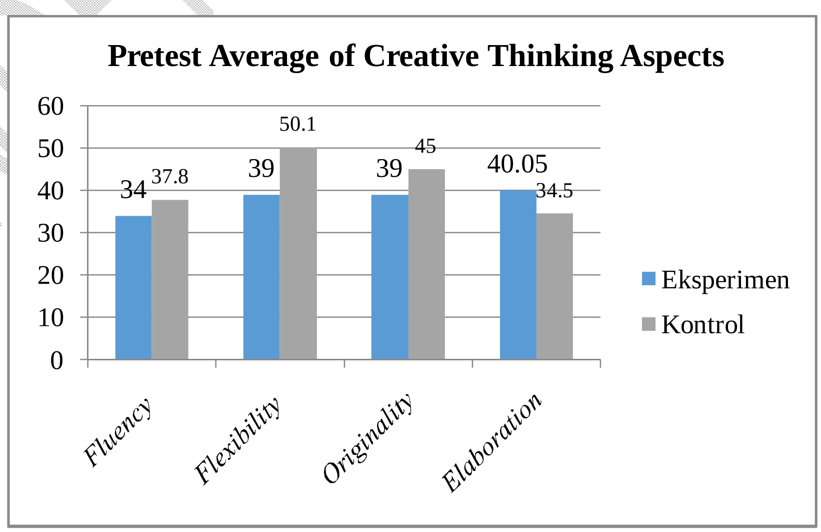

Figure 2. Comparison of the average pretest scores for the experimental class and the control class on aspects of creative thinking

Based on the results of students' creative thinking abilities for each indicator, the average initial creative thinking abilities of students on the Fluency, Flexibility, and Originality indicators in the experimental class is lower than in the control class. However, for the experimental class, the final average score of students' creative thinking abilities on the four indicators measured, Fluency, Flexibility, Originality, and Elaboration, was higher than the control class.

Analysis Increased creative thinking abilities.

a. Normality Test of Pretest and Posttest Values

The Normality Test aims to find out whether the population is normally distributed. The normality test used in this writing is Kolmogorov-Smirnova. The results of normality test calculations using the Kolmogorov Smirnov test for pretest and posttest scores can be seen in Table 1

Table 1 Normality Test Results of Pretest and Posttest Values

Class		*Kolmogorov-Smirnov*[a]			*Shapiro-Wilk*		
		Statistic	df	Sig.	Statistic	Df	Sig.
Creative Thinking	Pretest Experiment	,219	30	,001	,796	30	,000
	Posttest Experiment	,209	30	,002	,922	30	,030
	Pretest Control	,298	30	,000	,847	30	,001
	Posttest Control	,286	30	,000	,832	30	,000

The normality test in this study shows that the Sig. of the student's creative thinking skills variable in the Kolmogorov Smirnov normality test with an experimental class pretest of 0.001, a control class pretest of 0.000 and an experimental class posttest of 0.002 and a control class posttest of 0.000, where this value is smaller than the alpha level of 5% (0.05). Decisions are taken based on the size of the Sig value. 0.000 ≤ 0.05, 0.001 ≤ 0.05, and 0.002 ≤ 0.05, namely rejecting H0 and accepting H1, which means the data comes from a population that is not normally distributed. Based on the normality test results as a requirement for analysis tests, which show that the data distribution is not normal and can be used for further analysis. In this case, it is the Mann-Whitney test.

Mann Whitney test

The Mann-Whitney test compares two unrelated or independent samples whose distribution is abnormal. It is an alternative to the independent t-test for independent samples when normality requirements are not met.

Table 2 Output of statistical test results using the Mann-Whitney test

Students' creative thinking	
Mann-Whitney U	221,500
Wilcoxon W	686,500
Z	-3,440
Asymp. Sig. (2-tailed)	,001

Based on the statistical test output of the Mann-Whitney test for the Asymp value. Sig. (2-tailed) of 0.001 is smaller compared to 0.05. Then, the probability value Asym can be decided. Sig. (2 tailed) ≤ 0.05, then H0 is rejected and H1 is accepted. The conclusion is that there is a significant difference or influence between the creative thinking abilities of students who apply the PBL learning model using virtual laboratories.

Results of the Observation Sheet on Students' Creative Thinking Ability

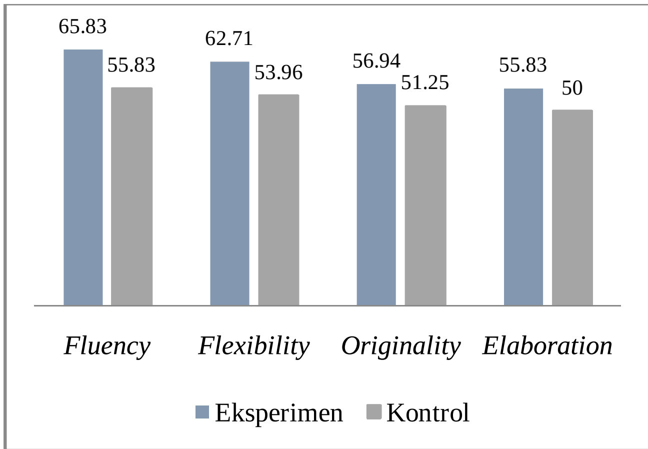

Figure 3. Comparison of the results of students' creative thinking abilities in each aspect in the experimental class and control class

Based on the average results of the observation sheet on students' creative thinking abilities in the experimental class, it can be seen that the percentage of aspects of fluency is 55.83, flexibility is 53.96%, originality is 51.25%, and elaboration is 50%. Meanwhile, in the control class, the percentage obtained for each aspect was 55.83% fluency, 53.96% flexibility, 51.25% originality, and 50% elaboration. A comparison of these results shows that students' creative thinking abilities in every aspect of the experimental class are higher than those in the control class.

According to the results of this research, the PBL model using virtual laboratory media requires students to solve problems related to situations in everyday life by encouraging them to think and providing lots of ideas. It aims to train students in creative thinking. Syntax analysis of PBL models using virtual laboratories.

With the help of a virtual laboratory, students' problem-solving abilities increase. It is in line with research conducted by Maulidah & Prima (2018), the results of abilities in the cognitive and environmental aspects of the science laboratory for students who used the virtual laboratory with Phet simulations on sound wave material experienced an increase in the excellent category. Apart from that, in group discussions, conclusions will emerge from the ideas generated to answer problems. It is supported by research by Handayani et al. (2019) through discussions allowing students to express their views and clarify their ideas; this strategy effectively increases student involvement in class. The benefits of discussion include helping students develop critical thinking, self-awareness, appreciation of different perspectives, and the ability to take action (Handayani et al., 2019).

PBL-based learning using laboratory media can increase students' interest in science lessons, especially harmonious vibrations, making learning more meaningful and helping students solve real-life problems. The PBL model using virtual laboratories also motivates students to practice critical thinking and analysis and improve high-level thinking skills. Through learning activities involving students, applying the PBL model using virtual laboratories can also improve students' creative thinking.

Additionally, virtual laboratory media PBL was used in the experimental class, and the PBL model was applied in the control class, with the results of the Mann-Whitney Test analysis for the Asymp value. Sig. (2-tailed) is 0.001 <0.05, then H0 is rejected, and H1 is accepted. The PBL learning model can significantly influence students' creative thinking abilities when applied using virtual laboratories.

During the learning process, one observer observes the teacher's activities, while two others observe the students' activities each time the meeting occurs. In learning using the PBL model and virtual laboratories, students are expected to be able to solve problems related to learning that exist in everyday life by providing lots of ideas so that students are trained to think creatively.

During the learning process, students experience difficulties discussing how to solve problems because they need help understanding the learning objectives set by the teacher. Teachers also need help directing students to formulate problem hypotheses and providing sufficient motivation, so the discussion process at the first meeting does not reach the optimal level.

The learning process using the PBL model with virtual laboratory media follows a constructivist approach, where the teacher is a facilitator who supports students to develop curiosity and interest in the learning material. This approach is consistent with constructivism principles, emphasizing the importance of students' active involvement in learning. According to Yilmaz (2008), constructivism is a concept that states, "Learning is development." It requires discovery and self-organization by the learner (students). Therefore, teachers must allow students to ask questions, generate hypotheses, and learn in their way.

From these two conditions, it can be concluded that why students' creative thinking abilities are different. In the experimental class, students are given treatment according to the PBL model with virtual laboratory media, which requires them to solve given problems. It causes students to be trained to provide various ideas and concepts, and they become interested when facing problems because the learning process involves them a lot, such as using virtual laboratories in learning. On the other hand, in the control class, although students were also treated with the PBL model, their learning activities did not use a virtual laboratory, so students' interest in learning was still less visible; they also tended to look for answers from textbooks without needing to think about other alternative answers.

As previously discussed, students' activity in generating ideas for solving problems increased at every second learning meeting. However, the relationship between ideas and the material studied at the first meeting was less significant than in the second meeting. The average results of cognitive assessments and observations show that students' creative thinking abilities in harmonious vibration material have increased in the experimental class compared to the control class. In the experimental class, the teacher applies the PBL model using a virtual laboratory, while in the control class, the PBL model is applied without a virtual laboratory. It shows that using the PBL learning model with virtual laboratory media in the experimental class influences students' creative thinking abilities.

Even though the experimental class's virtual laboratory-based PBL learning model further improves students' creative thinking abilities compared to the control class, statistical data shows that the average score on students' essay exams and creative thinking ability observation sheets is still low and has not reached the excellent category. This is because students in learning have yet to become accustomed to using the PBL model with virtual laboratory media. Apart from that, the essay test questions make students feel confused because they are not used to the types of questions requiring creative thinking skills.

Apart from that, the use of virtual laboratories also helps improve students' creative thinking abilities; by the same findings in research conducted by Yildirim (2020), the qualitative findings obtained are that the application of virtual laboratories increases students' interest, curiosity, and motivation in studying science. Apart from that, quantitative findings show that the implementation of virtual laboratories has a positive effect on students' learning in the cognitive area; this can be seen from the average score of experimental group students of 62.90 and control group students of 48.70. Apart from that, research by Asiksoy (2023) shows that physics experiments based on Phet simulations positively affect students' learning achievement. It has also been revealed that most students positively perceive virtual laboratory activities.

Conclusion

Based on the research results, it is concluded that the use of the Problem-Based Learning (PBL) model using the Virtual Laboratory significantly influences students' creative thinking abilities in harmonious vibration material in class VIII SMPN 17 Jambi City.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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