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The Effectiveness of the PhET-Assisted Creative Problem Solving Model on Students' Creative Thinking Abilities and Cognitive Learning Outcomes

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Abstrak: This research aims to determine the effectiveness of the PhET-assisted creative problem solving model on creative thinking abilities and student learning outcomes in vibration, wave and sound materials. In this research, the samples taken were determined based on the characteristics of the two classes which were almost the same (homogeneous). The characteristics used are the average UAS scores of two classes which are close to the same and the science teacher who teaches in the same class. The sample chosen was class VIII with class A as the control class and class B as the experimental class with a total of 16 students in each class. This research uses an experimental method with a nonequivalent control group design. Data on students' cognitive learning outcomes were taken using a test method in the form of 15 multiple choice questions, while students' creative thinking abilities used a test method in the form of 5 descriptive questions which had been tested for validity and reliability with a significance level of 5%, resulting in rcount > rtable. Research data was obtained from pretest-posttest scores and analyzed using the MANCOVA statistical test. The results of the multivariate analysis show that the sig value is <0.05, namely 0.001 <0.005, which means that there is a significant influence. The N-gain results show an increase in creative thinking abilities by 56.57% and an increase in students' cognitive learning outcomes by 57.08% which is included in the medium category. Therefore, it can be concluded that the use of the creative problem solving model assisted by PhET significantly increases students' creative thinking abilities compared to conventional learning. In addition, there is a significant increase in the cognitive learning outcomes of students who use this model. The implementation of PhET as an interactive learning tool opens up opportunities for students to understand science concepts in a more in-depth and contextual way. Implications of these findings include increased student engagement, development of innovative learning models, and emphasis on problem-based learning. This research contributes to educational practitioners and researchers in understanding the potential of the PhET-assisted creative problem solving model as a practical approach to improving students' learning outcomes and creative thinking abilities in the context of science learning.

Keywords: *creative problem-solving model, phet, creative thinking skills, cognitive learning outcomes.*

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INTRODUCTION

Education has a very important role in supporting the needs of all aspects of human life. This is because education has a direct influence on human development and all aspects of life. Changes in the world of education need to be continuously carried out to support better changes in the future through the learning process.

Currently, the condition of education in Indonesia shows several challenges that encourage educational practitioners to focus on developing creative thinking abilities. Several factors that support the need to train creative thinking skills among students in Indonesia involve aspects of the curriculum, globalization, technological developments and future competition. The following are several points that can explain this condition: 1) Developing curriculum, 2) Globalization Challenges, 3) Technological Development, 4) Future Competition, 5) Challenges of Traditional Education, and 6) 4C demands (Communication, Collaboration, Critical Thinking, Creativity)

Along with developments over time, the education curriculum in Indonesia has undergone changes to better adapt to global demands and the needs of the job market. The ability to think creatively is considered a critical competency that students need to succeed in an ever-changing world. Globalization has had a significant impact on student competency demands. Students not only need to master basic knowledge, but also have the ability to adapt, innovate and solve problems creatively in order to compete globally. Technological developments are accelerating changes in the way we work and interact. Students need to be trained to not only be consumers of technology, but also producers and creative thinkers who can face the challenges of modern technology.

Tight competition in the job market requires graduates who not only have knowledge, but also the ability to think creatively to solve problems and create innovative solutions. Traditional learning methods that are rote memorization (memorization) do not support the development of creative thinking abilities. Therefore, educational practitioners are required to look for more innovative and learning-oriented approaches that encourage student creativity. Current global and industrial demands emphasize the importance of 4C skills, namely the ability to communicate, collaborate, think critically and think creatively. The ability to think creatively is an essential element in responding to these demands.

One of the learning objectives is for students to improve their creative thinking abilities. The National Education Standards Agency (BSNP) explains that in 21st century learning requires skills called Learning and Innovation Skills (learning and innovation skills) which consist of 4 aspects, namely critical thinking (critical thinking), communication (communication), collaboration (collaboration/cooperation), and creativity (creativity) (Wijaya et al., 2016). By understanding this condition, education practitioners in Indonesia are encouraged to design learning strategies that facilitate the development of students' creative thinking abilities. A learning approach that emphasizes exploration, innovation and problem solving can help students develop skills relevant to future demands.

Creativity can make students more integrated with the environment. So that in the learning process students are expected to be able to solve problems in a creative way, not just memorize. In line with this statement, it can be said that creative thinking skills are one of the cognitive aspects that must be considered in the learning process, because creative thinking skills are closely related to student learning values. The relationship in question is where the ability to think creatively is directly proportional to the student's learning value and vice versa (Antika & Nawawi, 2017; Jaber & Kurniati, 2019). The phenomenon of many young entrepreneurs is proof that creativity is very useful in global competition. The same thing was also conveyed by Ghasemi et al (2011) in his research which shows that there is a relationship between creativity and entrepreneurship in high school students in Shiraz.

The results of observations regarding science learning carried out in one of the junior high schools showed that the level of students' creative thinking abilities was in the low category, this was because the learning process was still teacher-oriented (teacher centered). A learning process that only originates from teachers results in students not being trained to develop skills in solving problems and unable to encourage students to think creatively. If this situation continues, students will experience difficulty applying the knowledge they gain in class to real life, resulting in low student learning outcomes. (Marisyah et al., 2016; Nugraha et al., 2017). The low ability to think creatively in science material must be addressed immediately, because ongoing difficulties can cause students to have difficulty understanding further science concepts. (Haqiqi & Sa'adah, 2018).

The low science abilities of students in Indonesia can also be seen from the data from the PISA (Program for International Student Assessment) study. Based on the science capability assessment, 2015 shows that Indonesia experienced an increase in its average score compared to 2012. The 2018 PISA study saw a decrease in science competitions, with an average score of 396. This decrease placed Indonesia in 8th position from the bottom (Fuadi et al., 2020).

Based on the problems that occur during the science learning process, it is necessary to use learning models that actively involve students to develop students' creative thinking abilities. The ability to develop creative thinking is expected to be accompanied by increased student cognitive learning outcomes. Creative thinking abilities can be trained in science learning through approaches that stimulate exploration, innovation and problem solving. The creative problem solving (CPS) learning model can be a solution to overcome problems with students' thinking abilities and cognitive learning outcomes. The use of CPS learning trains students to improve their creative thinking skills in solving problems which focuses on strengthening skills and creatively organizing solutions. The CPS learning

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model uses group brainstorming sessions which can create space for students to stimulate, share and exchange creative ideas (Malahayati, 2017; Sari & Noer, 2017; Malisa et al., 2018).

The Creative Problem Solving (CPS) learning model is a learning model that uses a focus on teaching and skills in organizing creative ideas and solving problems through systematic techniques followed by strengthening skills and organizing creative solutions so as to improve students' creative thinking abilities. The Creative Problem Solving (CPS) learning model can be considered trustworthy for solving educational problems in Indonesia because CPS designs a learning framework that is specifically designed to stimulate students' creative thinking abilities. In the midst of global demands and rapid changes, the ability to think creatively becomes critical for responding to complex problems. With its focus on skills such as problem solving, creativity, and critical thinking, CPS meets the demands of the 21st century. This learning can help students develop the skills needed to succeed in the modern era. Indonesia has introduced the 2013 Curriculum which emphasizes the development of 21st century skills. CPS can be integrated well in this curriculum because it emphasizes the skills needed by students (Malisa et al., 2018).

According to Shoimin (2016), the learning process using the CPS model consists of four steps, namely 1) problem clarification, 2) expression of opinions, 3) evaluation and selection, 4) implementation. The advantages of using the CPS model include being able to train students to design an invention, train students to think and act creatively, solve problems faced realistically, identify and carry out investigations, interpret and evaluate the results of observations, stimulate progress in the development of students' thinking to solve existing problems dealt with quickly. Apart from the advantages, the use of the CPS model also has several disadvantages, including requiring a more extended time allocation compared to other learning models and several topics that are difficult to apply the CPS learning model because the limited laboratory equipment makes it difficult for students to see and observe and conclude events to that concept (Shoimin, 2016).

The shortcomings and limitations contained in the application of the CPS model can be complemented by the use of technology with virtual-based experiments that can be operated anywhere and at any time so as to shorten the time allocation. One type of virtual-based experiment is a PhET (Physics Education and Technology) simulation. PhET simulation is a learning medium in the form of a series of laboratory equipment in the form of interactive multimedia-based software that can simulate laboratory activities such as natural experiments. (Muzana & Astuti, 2017).

The use of PhET learning media in the learning process can be used as an effective alternative to replacing direct experiments because it is more flexible, safe, easy to set up, cost-effective, and faster to carry out than direct experiments (Gonzales et al., 2017). The use of technology, simulations, or hands-on experiments allows students to explore science concepts in an interactive way. This provides opportunities for students to create, observe and investigate which can stimulate creative thinking. Apart from that, considering the current condition of Indonesian education which demands to keep up with technological developments, choosing PhET learning media which can display material visually, audio and multimedia could be an option in the learning process to stimulate students' senses and imagination. PhET media can integrate multimedia elements that can make science material more interesting and motivate students' creative thinking.

Based on the background above, researchers see that the learning model applied by teachers greatly determines students' thinking abilities and cognitive learning outcomes. Therefore, researchers want to conduct research that has not been done before by integrating technology-based learning media into learning models which are expected to improve students' creative thinking abilities and cognitive learning outcomes. This research has significant implications for the development of science learning methods in Indonesia. By exploring the effectiveness of the Creative Problem Solving (CPS) Model assisted by PhET technology, this research is expected to make a valuable contribution to our understanding of how this approach can influence students' creative thinking abilities and cognitive learning outcomes.

METHOD

The type of research used is quasi experimental design research in the form of a nonequivalent control group design. The population in this study were all class VIII students in the even semester of the 2020/2021 academic year with the sample selected using a purposive sampling technique so that class A was obtained as the control class and class B as the experimental class. The instruments used

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involve creativity tests and cognitive tests with vibration, wave and sound materials. The test form used in this research is 15 multiple choice questions to measure students' cognitive learning outcomes and 5 essay questions to measure students' creative thinking abilities. The questions used have been validated and tested first with the aim of knowing their validity, differentiation, level of difficulty and reliability. The experimental group received learning using the CPS model assisted by PhET, while the control group received conventional learning. Data was collected before and after treatment using prepared instruments (pretest-posttest). Analysis to determine the effectiveness of the learning model used the MANCOVA test and the N-gain test. Assumption tests used for analysis include: homogeneity test of the variance covariance matrix and mutivariate normality test. Hypothesis testing at the 5% level.

RESULTS AND DISCUSSION

The creative problem solving (CPS) learning model is a learning model that uses a focus on teaching and skills in organizing creative ideas and solving problems through systematic techniques followed by strengthening skills and organizing creative solutions so that it can improve students' creative thinking abilities (Malisa et al., 2018). The application of the CPS model in this research is combined with the use of PhET simulation. The use of PhET simulations plays a role in emphasizing the relationship between actual life events and the knowledge that has been studied (Maryam, 2019). Apart from that, PhET simulation can complement the shortcomings of the CPS model, namely by reducing the time allocation required in implementing the CPS model because when used, the PhET simulation can be operated quickly without making preparations which can take a lot of time. The learning process using the CPS model begins by providing a problem shown in the PhET simulation. The problems contained in the PhET simulation are studied individually based on the instructions contained in the student worksheet. At this stage the teacher emphasizes that each individual is able to formulate a problem based on everyday phenomena (problem clarification). Next, the teacher guides students to exchange arguments with each other through classical discussions to obtain problem solving strategies that have been formulated (brainstorming). The interaction of teachers with students and students with students is an integrated concept of a learning activity (Sudjana, 2005). Guidance and encouragement in carrying out discussions to obtain explanations and solve problems will make students active and creative (Fikri et al., 2018). After getting a problem solving strategy, students are directed to answer several questions reviewing the problem solving strategies offered (evaluation and selection). Students will express conclusions from the discussions that have been held and the teacher gives scores in the form of points to students who dare to express their opinions. At the end of the lesson, the teacher reviews the material by giving quiz questions to determine students' understanding (implementation).

The materials used in this research are vibrations, waves and sounds because these materials are essential materials and are closely related to students' daily lives. The preparation of the questions is also adjusted to the material of vibrations, waves and sounds. The questions consist of 15 multiple choice questions and 5 description questions, where 5 description questions focus on indicators of creative thinking. The questions used have gone through trials carried out on groups that have previously received material on vibrations, waves and sounds. The results of the homogeneity test on samples that were selected using a purposive sampling technique showed that the two samples were homogeneous with a sig value = 0.421, sig > 5%. The homogeneity data carried out showed positive results, so the next step is implementation. Implementation was carried out in class A as the control class and class B as the experimental class.

Learning in the control class uses conventional learning models. In the control class, the teacher explains the material as a whole. Meanwhile, in the experimental class, learning is carried out using the CPS model assisted by PhET by involving students actively participating in group discussions which can direct students to see problems from different points of view so that students are able to find answers to questions in their own way so as to improve students' thinking abilities. This is in accordance with the results of research that has been carried out Hermansyah et al (2015) that students' mastery of concepts and creative thinking abilities achieved using the help of a virtual laboratory is higher than students who learn without using a virtual laboratory. The learning process at each meeting is carried out using student worksheets. The worksheet is one of the learning tools that must be used in implementing the 2013 curriculum learning (Prasetyowati, 2014). The worksheet used in both classes is the same, the only difference is the learning model and in the experimental class, the worksheet is

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prepared using problem solving steps based on the CPS learning model and is equipped with the use of PhET simulations, while the control class is given worksheet which is textual without problems. The average value of the worksheet students completed during the learning process increased from the first meeting to the third meeting. The increase in the average value of students' worksheet is shown in Table 1.

Tabel 1. Summary of Average Worksheet Scores

	Contol Class		**Experiment Class**	
	Average	**Gain (%)**	**Average**	**Gain (%)**
Worksheet 1	70.00	0	68.75	0
Worksheet 2	75.93	8	76.67	10
Worksheet 3	81.87	7	83.75	8

Paat et al (2021) stated that the application of problem-based learning model worksheets is a fascinating, fun and not dull model so that it can improve science learning outcomes and students' high-level thinking abilities. The effectiveness of the PhET-assisted CPS model is known from the difference in increasing students' cognitive learning outcomes and students' creative thinking abilities. The effectiveness of implementing the PhET-assisted CPS model can be seen from the significant differences in creative thinking abilities and cognitive learning outcomes of students who received different learning models after controlling for students' initial abilities and differences in the increase in pretest-posttest scores in both the control and experimental classes.

Creative Thinking Ability

Munandar (2017) revealed four indicators of creative thinking, including: fluency, namely the ability to produce many ideas that come out of one's thinking quickly, flexibility, namely the ability to see a problem from different points of view, looking for alternatives or different directions. Different, elaboration, namely the ability to develop ideas and add or detail details of a simple idea so that it becomes more interesting, and originality, namely the ability to come up with original ideas in one's own way. Data on creative thinking abilities was taken using a test technique in the form of a description with 5 questions to obtain pretest and posttest scores. The results of the pretest-posttest creative thinking abilities of control class and experimental class students can be seen in Figure 1.

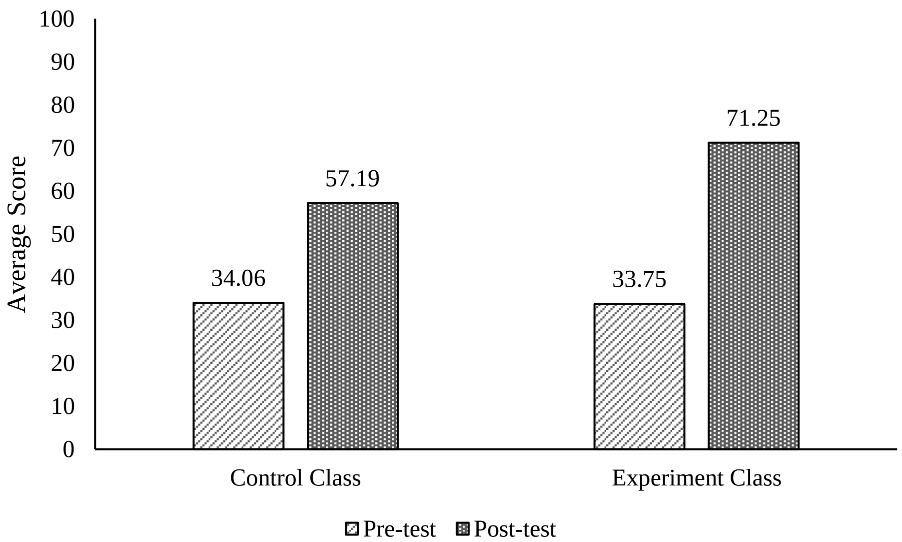

Figure 1. Average score of students' creative thinking ability in control class and experimental class (pretest-posttest)

Figure 1 shows that before being given treatment using the learning model in the control class and the experimental class, students had almost the same creative thinking abilities, after learning using the creative problem solving model assisted by PhET in the experimental class and the direct instruction model in the control class. The experimental class had a higher increase in average value compared to the control class. These differences in results explain that the creative thinking abilities of experimental

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class students are better than those in the control class. The percentage results of students' creative thinking criteria in the control and experimental classes after the pretest-posttest which show the effect of implementing the creative problem solving learning model assisted by PhET on vibration, wave and sound materials can be seen in Table 2.

Table 2. Percentage of Students' Creative Thinking Criteria Based on Pretest-Posttest Scores

Class	**Data**	**Frequency** *f*	**%**	**Category**
Control	Pre-Test	6	37.5	Enough Creative
		6	37.5	Less Creative
		4	25.0	No Creative
	Post-Test	4	25.0	Creative
		10	62.5	Enough Creative
		2	12.5	Less Creative
Experiment	Pre-Test	3	18.8	Enough Creative
		9	56.3	Less Creative
		4	25.0	No Creative
	Post-Test	1	6.3	Very Creative
		11	68.8	Creative
		4	25.0	Enough Creative

Table 2 shows that the percentage results of students' creative thinking abilities increased in both the control and experimental classes. These results explain that the percentage increase in creative thinking abilities in the experimental class was higher compared to the control class. Next, an analysis was carried out based on the indicators used to measure the increase in students' creative thinking abilities. The following is a recapitulation of the results of the analysis of 4 indicators based on students' pretest and posttest scores.

Table 3. Percentage of Analysis Results of Creative Thinking Ability Indicators

Indicator	**Percentage (%)** **Control Class**		**Experiment Class**	
	Pre-Test	**Post-Test**	**Pre-Test**	**Post-Test**
Fluency	25	55	23	69
Flexibility	50	78	42	81
Originality	19	38	17	50
Elaboration	35	57	41	78

Table 3 shows that the percentage of students' creative thinking abilities has increased in the four indicators used. The fluency indicator in the control class increased by 30% and the experimental class by 46%. The flexibility indicator increased by 28% in the control class and 39% in the experimental class. The originality indicator increased by 19% in the control class and increased by 33% in the experimental class. The elaboration indicator in the control class increased by 22%, while in the experimental class it increased by 37%. Based on the percentage increase, it can be seen that the experimental class had a higher percentage increase in the four indicators used compared to the control class. The fluency indicator is the indicator that has the highest percentage increase when compared to the other three indicators, both in the control class and the experimental class.

Cognitive Learning Outcomes

Data on cognitive learning outcomes was taken using a multiple choice test technique with 15 questions to obtain pretest and posttest scores. The pretest-posttest results of the cognitive learning outcomes of control class and experimental class students can be seen in Figure 2.

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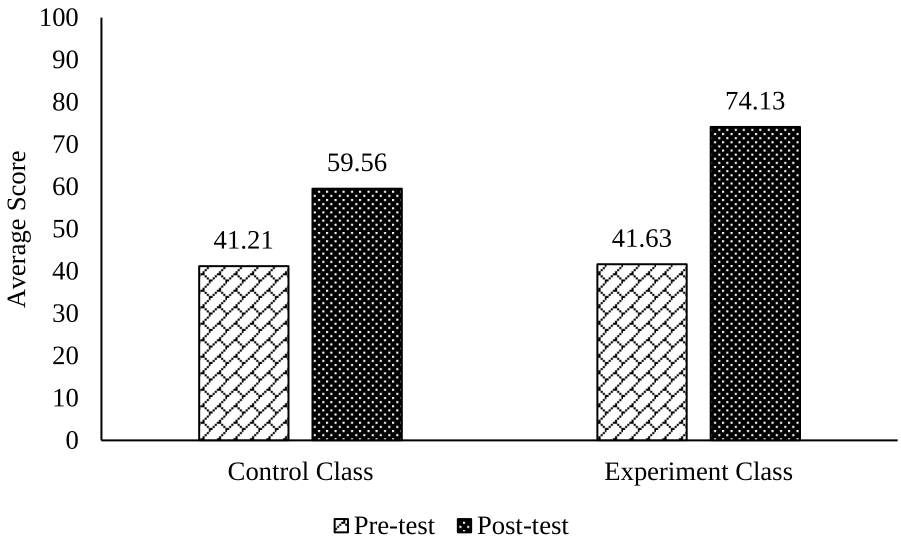

Figure 1. Average Value of Cognitive Learning Results for Control Class and Experiment Class Students (pretest-posttest)

Figure 2 shows that before being given treatment using the learning model in the control class and the experimental class, students had almost the same cognitive abilities after learning with the creative problem-solving model assisted by PhET in the experimental class and the direct instruction model in the control class, scores increased in both class. The experimental class had a higher increase in average value compared to the control class. These differences in results explain that the creative thinking abilities of experimental class students are better than those in the control class. The difference in average learning outcome scores shows that the creative problem solving learning model assisted by PhET can produce higher (better) learning outcome scores than learning outcomes using the direct instruction learning model. This is because the creative problem solving learning model is student centered where students are trained to discover concepts themselves through problem solving in understanding the material. This is in accordance with research Satriaman et al (2019) that learning carried out using a student centered approach is closely related to student learning outcomes.

The percentage results of students' cognitive learning outcomes in the control and experimental classes after the pretest-posttest which show the effect of implementing the creative problem solving learning model assisted by PhET on vibration, wave and sound material can be seen in Table 4.

Table 4. Percentage of Student Cognitive Learning Results Based on Pretest-Posttest Scores

Class	**Data**	**Frequency**		**Category**
		f	**%**	
Control	Pre-Test	1	6.3	Good
		3	18.8	Enough
		12	75	Less
	Post-Test	6	37.5	Good
		6	37.5	Enough
		4	25	Less
Experiment	Pre-Test	1	6.3	Good
		3	18.8	Enough
		12	75	Less
	Post-Test	3	18.8	Very Good
		12	75	Good
		1	6.3	Enough

Table 4 shows that the percentage of students' cognitive learning outcomes increased in both the control and experimental classes. These results explain that the percentage increase in cognitive learning outcomes in the experimental class is higher compared to the control class. The difference in the increase in students' pretest-posttest scores in the control class and experimental class was analyzed using N-

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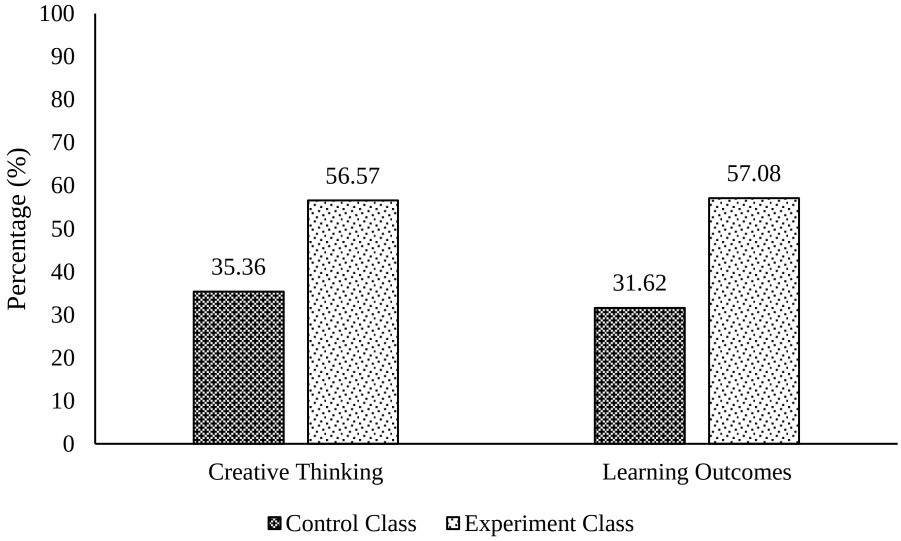
gain. The results of the N-gain test for creative thinking abilities and cognitive learning outcomes for the control class and experimental class are presented in Figure 3.



Gambar 2. Perbandingan N-gain Kelas Eksperimen dan Kelas Kontrol

Figure 3 shows the results of the analysis of pretest scores and posttest scores for the experimental class and control class which experienced an increase in cognitive learning outcomes and creative thinking abilities. The results of the analysis of the creative thinking abilities of the experimental class showed an N-gain of 56.57% in the medium category. Meanwhile, in the control class, the N-gain was 35.36% in the medium category. The results of the experimental class cognitive learning analysis showed an N-gain of 57.08% in the medium category. Meanwhile, in the control class, the N-gain was obtained at 31.62% in the medium category. The increase in the value of cognitive learning outcomes and creative thinking abilities for the control class and experimental class was in the medium category, but the experimental class obtained a higher score than the control class. So, it can be concluded that the creative thinking abilities and cognitive learning outcomes of the experimental class are better than the control class.

Multiple Analysis of Covariance (MANCOVA)

Based on the MANCOVA statistical test carried out, it can be described that there is a significant difference in creative thinking abilities between the experimental class and the control class after being given treatment in the form of learning with the PhET-assisted creative problem-solving model in terms of students' initial creative thinking abilities (pretest), as evidenced by $F = 15.216$ with $p = 0.001$; proven $p < 0.05$.

There was also a significant difference in cognitive learning outcomes between the experimental group and the control group after being given treatment in the form of learning with the creative problem solving model assisted by PhET in terms of students' initial abilities (pretest), as evidenced by $F = 48.984$ with $p = 0.001$; proven $p < 0.05$. From the results of this analysis, it is proven that there is a significant favorable influence of the PhET-assisted creative problem solving model on increasing students' creative thinking abilities and cognitive learning outcomes in terms of students' initial abilities. This is because the questions used for the pretest-posttest are contextual questions, so experimental class students are used to working on contextual questions through a problem solving learning process which can train students' fluency in solving problems and building their own knowledge. (Mahmudah, 2019). Meanwhile, the control class was not used to working on contextual questions, so there was a significant difference in influence for the two classes. Kasmaienezhadfard et al (2015) suggests that there are 2 factors that encourage the realization of individual creativity, namely encouragement from within oneself (intrinsic motivation) and encouragement from the environment (extrinsic motivation). PhET media can arouse curiosity and make students explore their knowledge towards understanding science concepts in the subject of vibrations, waves and sound.

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The application of the PhET-assisted CPS model in this research can be said to be successful because there are differences in students' cognitive learning outcomes and students' creative thinking abilities in the control class and the experimental class, namely the experimental class has a more significant improvement than the control class.. Putri et al (2019) which states that learning using the creative problem solving model has proven to be influential in improving students' creative thinking abilities. The CPS learning model can have a positive influence on creative thinking abilities because in its application students are presented with contextual problems to build thinking abilities in understanding a concept. The Creative Problem Solving (CPS) model assisted by PhET can improve students' creative thinking abilities and cognitive learning outcomes, which can be explained through several factors that are characteristic of this model: The integration of PhET (Physics Education Technology) with the Creative Problem Solving (CPS) model enhances the overall learning experience for students in various ways.

Firstly, PhET stimulates interactive learning by providing visual and interactive science simulations. These simulations engage students directly in exploring scientific concepts, stimulating their senses, and creating a more realistic learning experience. Additionally, PhET allows for virtual experiments, enabling students to conduct experiments without the need for expensive physical equipment or safety concerns. This provides them with the opportunity for more unrestricted exploration, free from physical limitations.

The application of the Creative Problem Solving (CPS) model further enriches the learning process. CPS focuses on the creative process of problem-solving, encouraging students to identify problems, develop ideas, and test solutions. This approach stimulates creative thinking in finding innovative solutions. Moreover, CPS is rooted in active learning, urging students to be active participants in formulating solutions and promoting a deeper understanding of concepts. The connectivity with everyday life contexts is another significant aspect. CPS, in collaboration with PhET, allows teachers to connect scientific concepts with real-life situations, providing context and relevance for students. This helps students see the practical applications and usefulness of scientific concepts. Furthermore, CPS encourages the application of scientific concepts in different contexts, fostering creative thinking and problem-solving skills.

Collaboration and communication are facilitated through CPS, naturally supporting group work and collaboration. Students can work together to solve problems and exchange ideas, enriching their learning experiences. The inclusion of PhET in CPS also promotes learning through discussions, allowing students to collectively solve problems and build a shared understanding of concepts. The evaluation process is enhanced with a performance-based model, considering not only the final results but also the thought processes of students. This measurement provides deep insights into students' creative thinking abilities and their understanding of concepts.

Lastly, the flexibility in learning is emphasized with CPS assisted by PhET, as it can be adapted to various skill levels and learning styles. This adaptability makes it relevant and integrable into various educational contexts. Overall, the combination of PhET and the CPS model creates a dynamic and effective learning environment. Through a combination of these features, the Creative Problem Solving model assisted by PhET can provide a learning experience that stimulates creative thinking abilities and increases students' cognitive understanding in science learning.

CONCLUSION

Based on the results of data analysis and discussion, it can be concluded that the use of the creative problem solving model assisted by PhET is efficacious in improving creative thinking abilities and student learning outcomes in vibration, wave and sound material which is proven by an increase in N-gain in the medium category. Learning using the creative problem solving model assisted by PhET should be implemented in schools to support improving students' creative thinking abilities and cognitive learning outcomes in studying science material, especially on the subject of vibrations, waves and sound.

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