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The Effect of Contextual Teaching and Learning Using PhET Media on Higher-Order Thinking Skills in the Energy Material

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Abstract: Natural and Social Sciences (IPAS) learning in schools often faces challenges, especially in improving students' higher-order thinking skills. One of the factors that results in low learning outcomes in higher-order thinking skills is the use of learning models that do not involve students fully and actively. Therefore, an innovative and effective learning model is needed, one of which is the contextual teaching learning model using PhET media. This study was conducted to examine the application of the Contextual Teaching and Learning (CTL) model using PhET media on energy materials in grade 4 elementary school, and the significant influence of the Contextual Teaching and Learning (CTL) model using PhET media on Higher Order Thinking Skills in energy materials in grade 4 elementary school. The method used is a quasi-experimental qualitative design with a one-group pretest-posttest design. Data in the study were obtained through observation, tests and documentation. The data analysis technique in this study uses observation sheets to see the application of the contextual teaching learning model using PhET media, with a score of 87.5 in the satisfactory category. Descriptive statistical data were obtained; the average pretest score was 44.00. Then, after applying the Contextual Teaching and Learning (CTL) learning model using PhET media, it increased to 90.87. The normality test obtained a pre-test value of 0.057 > 0.05, so the distribution of data in this pretest was distributed normally. As for the post-test, the results of higher-order thinking skills have a value of 0.541 > 0.05 with normal distribution. The hypothesis test uses the Wilcoxon Signed Ranks Test with a Mean Rank of 8.00 and a Sum of Rank of 120.00 with a significance value of 0.000, which means that it is less than the significance level (α) of 0.05, so that H_0 is rejected. This means that there is a significant difference between pre-test and post-test scores. In conclusion, the Contextual Teaching and Learning (CTL) learning model using PhET media has an effect on Higher Order Thinking Skills in energy materials in grade 4 elementary school.

Keywords: Higher-Order Thinking Skills; Model Contextual Teaching and Learning; Simulasi PhET.

Introduction

The 21st-century knowledge era presents a challenging time for education in Indonesia. One of the challenges is that education must produce human resources who have comprehensive capabilities to overcome various life challenges. Adapting to the demands of today's education, students must have skills related to learning and innovation, proficiency in media and information, and competence in personal and professional life [1].

In supporting the learning process, it can be done with certain methods, one of which is using teaching materials as a learning medium. In the 21st century, the use of technology in learning has opened the door to significantly improving students' high-level thinking skills. Various online learning platforms provide interactive tools such as simulations, educational games, and online discussions that stimulate high-level thinking skills. For example, in natural science lessons, learners can use virtual simulations to experiment and observe the impact of changes in a measurable object that allows them to develop high-level thinking skills [2].

Simulasi virtual interaktif dalam The learning that students can use is PhET simulation. This simulation is designed to help learners understand difficult concepts through virtual experiments that allow for risk-free exploration [3]. By utilizing this technology in understanding learning in Contextual Teaching and Learning, teachers can create an engaging learning experience and provide opportunities for students to develop high-level thinking skills [4].

Contextual Teaching and Learning (CTL) is a learning approach that puts the real-life context as a foundation for understanding academic concepts. This approach emphasizes the relevance of the subject matter to the daily lives of learners, thus enabling them to more easily understand and apply knowledge in different contexts [5]. In this context, the use of PhET Simulation as a learning tool adds an interactive and visual dimension that can increase student engagement. The integration of these two approaches, the Contextual Teaching and Learning learning model and the PhET simulation media, has the potential to create an innovative learning environment, encourage active engagement, and significantly improve students' understanding of concepts and Higher Order Thinking Skills. This study will specifically focus on Energy material in grade VI of elementary school, which is often considered abstract by students.

Based on observations made on 30 March 2024, the fourth grade shows a lack of demand for high-level thinking skills of students or being in Lower Order Thiking Skills (LOTS). The LOTS learning pattern only requires students to answer factual questions whose alternative answers are

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only one or in the form of something that can be found directly in books or memorized. The dominant learning model of LOTS, for the next class development, will provide students as passive objects. In the ideal position of students as active learning subjects, not as passive learning objects. Improving high-level thinking skills, teachers can develop problems that are able to develop high-level thinking skills in students, such as developing HOTS-based questions. HOTS questions are questions that are compiled for the purpose of improving students' thinking skills [6]. Students are said to be able to solve problems if they can investigate the problem and apply their knowledge to new situations [7]. HOTS, known as Higher Level Thinking Skills in Review from the Cognitive Realm in Bloom's Taxonomy, is at the analysis, synthesis and evaluation level. Applying these HOTS questions must follow the set rules, both the writing of questions in general and rules based on the thinking level of the students who work on the questions [8]. The improvement of HOTS through the integration of Contextual Teaching and Learning (CTL) with PhET media directly encourages the goal of an independent curriculum in the Pancasila student profile, one of which is critical and creative thinking. Therefore, teachers must improve students' thinking skills using HOTS questions and have more in-depth knowledge on applying science questions that are classified as HOTS categories based on the Bloom Taxonomy in the learning carried out [9]. Based on the background of the problem that the author has described above, the author is interested in discussing and raising the problem into a thesis title, "The Effect of Contextual Teaching Learning Using PhET Media on Higher Order Thinking Skills in Grade 4 Energy Materials at SD Islam ATS Tsiqoh Palangka Raya.

Research Methods

This type of research is quantitative. A Quasi-Experiment is an experiment with a treatment, impact measurement, and experimental unit, but does not use random assignments to create comparisons to conclude treatment changes [10]. The quasi-experimental research method is a research method whose control is carried out on only one variable, namely the variable that is considered the most dominant [11]. The design form used by the researcher is the One-Group Pretest-Posttest Design, where, before being given treatment, the subject is given a pre-test. After being given treatment, it is also retested with the same test questions as the final test (post-test) [12].

Table 1. Desain One Group Pretest Posttest

Pre-test	Perlakuan	Post-test
O1	X	O2

Information:
X : Treatment with the Contextual Teaching and Learning model
O1 : Initial test before treatment
O2 : Final test after treatment

The population in this study is all grade IV students totaling 15 people. The sampling technique in this study uses the quota sampling technique. In this study, the researcher took 15 samples to be studied.

In this study, we look at the influence of the Contextual Teaching and Learning (CTL) learning model using PhET media on Higher Order Thinking Skills in grade 4 energy materials at SD Islam ATS TSIQOH Palangka Raya.

Results and Discussion

The results of this study have the effect of Contextual Teaching and Learning (CTL) learning using PhET media on Higher Order Thinking Skills in the 4th grade energy material of SD Islam ATS TSIQOH Palangka Raya. The stages of implementing the contextual teaching learning model using PhET media are introduction to the material (constructivism), inquiry, discussion and question and answer (questioning), learning community (learning community), modelling (modelling), reflection and authentic analysis. This meeting was held for three meetings with three observers. The score obtained from the overall observation results was 87.5% in the satisfactory category. The results of the effectiveness of the pretest, posttest, normality test and hypothesis. The average pretest score of 44.00 was obtained, and then after applying the Contextual Teaching and Learning (CTL) learning model using PhET media, it increased to 90.87. The normality test using the Shapiro test was obtained, with a pre-test score of 0,057 > 0,05, indicating that the data in this pretest is normally distributed. Meanwhile, for the post-test, the results of the higher order thinking skills ability have a value of 0.541 > 0.05, which has a significance, namely the sig > value of 0.05, so the data in this test is normally distributed. Furthermore, the hypothesis test uses the Wilcoxon Signed Ranks Test with a Mean Rank of 8.00 and a Sum Of Rank of 120.00 with a significance value of 0.000, which means that it is less than the significance level (α) of 0.05, so that H_0 is rejected. This means that there is a significant difference between pre-test and post-test scores.

The use of contextual teaching and learning learning models using PhET media with stored energy (potential) and independent energy (kinetics) material in Natural and Social Sciences (IPAS) subjects, based on the experience of using the model, the learning activities of teachers and students in the classroom are observed through instruments in the form of observation tables. The instrument goes through a consultation and validation process with expert lecturers before being used to collect research data. The application of practising the material studied, including methods, concepts and theories according to a systematic plan [13]. Application is defined as one of the activities of a group or individual in using ideas, methods or principles in real situations to achieve certain goals. In this study, the contextual teaching and learning learning model was applied to improve the results of students' higher-order thinking skills in stored energy (potential) and released energy (kinetics) materials. This study aims to examine the application of the contextual teaching learning model using PhET media in the ability of higher-order thinking skills of grade IV students of SD Islam ATS Tsiqoh Palangka Raya. Learning is carried out in three meetings with stages that have been adjusted to the steps of the contextual teaching learning model. The stages of implementing the contextual teaching learning model using PhET media are:

a) Introduction to Material (Constructivism): The teacher conveys the learning objectives and introduces the material of stored energy (potential) and released energy (kinetic).
b) Inquiry: The teacher invites students to leave the classroom for 2/3 minutes to analyze the stored energy in the school environment. (C4)
c) Discussion and Questioning: After they find the stored energy in the environment around the school, they are given the opportunity to ask questions or discuss together.
d) Learning Community: Teachers distribute student worksheets and ask students to open the mobile phones they have brought.
e) Modelling: The teacher provides an explanation of the steps to use the interactive media of the PhET simulation. After the teacher finished giving an example of how to use the PhET simulation, the teacher gave the students worksheets that they worked on together in their respective books.
f) Reflection: Participants are given time to reflect on what they have learned during this activity. The teacher asks the students about the difficulties they face and what they learn from this experience.
g) Authentic Assessment: Students work on Post Test questions.

The results of this study have the effect of Contextual Teaching and Learning (CTL) learning using PhET media on Higher Order Thinking Skills in the 4th grade energy material of SD Islam ATS TSIQOH Palangka Raya. The calculation on the results of the observation assessment from 3 observers in the use of the contextual teaching learning model using PhET media of science subjects is able to improve the ability of higher-order thinking skills of grade IV students of SD Islam ATS Tsiqoh Palangka Raya as follows.

Table 2. Observer Observation Results

No.	Observer	Total Scores obtained	Value	Category
1	Observer 1	53	82.8	Satisfactory
2	Observer 2	54	84	Satisfactory
3	Observer 3	63	98	Very Satisfying

Based on the results of observation calculations by 3 observers who have assessed and observed the implementation of the use of the contextual teaching learning model using PhET media, it provides evidence that students become more active in the learning process and better understand the concepts of stored energy (potential) and released energy (kinetics) after participating in learning. This learning model has been proven to be influential in improving the ability of higher order thinking skills and encouraging the active involvement of students during the learning process in the IPAS subject activities of stored energy (potential) and independent energy (kinetics) materials carried out in grade IV, it can be said that it is influential in helping students to improve the ability of higher order thinking skills. The use of the contextual teaching learning model by the teacher was categorized as satisfactory.

The significant influence of the Contextual Teaching and Learning (CTL) model using PhET media on Higher Order Thinking Skills on energy materials in grade 4 of elementary school. Previously, students ran a pre-test in the form of 9 description questions to measure initial knowledge, followed by a final test (post-test) after students were treated with the contextual teaching learning model. The observation sheets and questions in this study have been validated by expert lecturers, namely Mr. Jhelang Annovasho, S.Pd., M.Si and Hj. Nurul Septiana, M.Pd, who is a lecturer at the Department of Mathematics and Natural Sciences Education at UIN Palangka Raya. His selection as a validator was based on several considerations, namely:

a. Expertise in the field of MIPA education: As a lecturer in the Department of Mathematics and Natural Sciences Education, he has a deep understanding of the materials and learning methods that are in accordance with this research.
b. Academic and research experience: Have experience in assessing and developing research instruments, so as to be able to provide constructive input to improve the quality of instruments.
c. Objectivity and credibility: With a strong academic and professional background, he can conduct objective validation and ensure that research instruments are in accordance with applicable scientific standards.

Based on these considerations, the validation carried out is expected to improve the quality and reliability of this research instrument.

The researcher used a descriptive statistical analysis test to analyze the differences in the results of students' higher-order thinking skills in the initial test (pre-test) and the final test (post-test). The results of the analysis stated the difference between the scores before and after the application of the contextual teaching learning model, which is presented in the following table.

Table 3. Descriptive Statistical Data Analysis

Descriptive Statistics					
	N	Min	Max	Mean	Std. Deviation
Pretest	15	30	60	44.00	10.385
Posttest	15	83	98	90.87	4.121
Valid N (listwise)	15				

The results of the pre-test or initial test of grade IV students before being given treatment can be seen using the contextual teaching learning model, with the highest score of 60 and the lowest score of 30, with an average score of 44.00. After carrying out learning activities by providing treatment to class IV using the contextual teaching learning model, class IV was given a post-test or final test to see the results of higher-order thinking skills of energy materials, with the highest score of 98 and the lowest score of 83. The average score on the post-test results is 90.87. Based on the results of the consideration of the average score of the pre-test and post-test results, it can be seen that there is a significant influence on the improvement of the higher-order thinking skills of IPAS grade IV students of SD Islam ATS Tsiqoh Palangka Raya before and after being given treatment.

Furthermore, the data normality test is a form of testing the normality of data distribution. The purpose of this test is to determine whether the data obtained is normally or abnormally distributed. The criteria in this study are that if the significance value is > 0.05, then the data is normally distributed; if it is < 0.05, then the data is not normally distributed. The results of the data normality test on the results of students' higher-order thinking skills can be seen in the table below.

Table 4. Data Normality Test

Normality Test Results

Tests of Normality

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest Hasil Higher Order Thinking Skills	.185	15	.178	.886	15	.057
Postest Hasil Higher Order Thinking Skills	.175	15	.200*	.951	15	.541

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Based on the results of data analysis in the table above using the Shapiro-Wilk test, a pre-test value of 0.057 > 0.05 was obtained, so the distribution of data in this pretest was normally distributed. Meanwhile, for the post-test, the results of the higher order thinking skills ability have a value of 0.541 > 0.05, which has a significance, namely the sig > value of 0.05, so that the data in this test is distributed normally.

a.

Table 5. Hypothesis

Wilcoxon Signed Rank Test

		N	Mean Rank	Sum of Ranks
posttest - pretest	Negative Ranks	0[a]	.00	.00
	Positive Ranks	15[b]	8.00	120.00
	Ties	0[c]		
	Total	15		

a. posttest < pretest
b. posttest > pretest
c. posttest = pretest

Seeing the influence of the contextual teaching learning model assisted by PhET simulation media on the ability of higher-order thinking skills in the cognitive realm of students of stored energy materials and released energy. The Wilcoxon test was used in this study to test the hypothesis, where the analysis was carried out using the Wilcoxon Signed Ranks Test. This method was chosen because the research involved a comparison of the results of higher-order thinking skills before and after being given treatment, namely the application of the contextual teaching learning model assisted by PhET simulation media [17-19. This test compares the scores before and after the test of grade IV students to determine if there is a significant difference after being given the treatment. In other words, the Wilcoxon Signed Ranks Test is used to determine whether the independent variable (X), which is the learning model implemented, has a significant influence on the bound variable (Y), which is the result of students' higher-order thinking skills. Significance means an influence that applies to the population and can be generalised [20-21]. The provisions are:

b. If the calculation > table, the independent variable partially has a significant effect on the dependent variable (Ho is rejected, Ha is accepted).

If the calculation < table, the independent variable partially has no significant effect on the dependent variable (Ho is accepted).

Based on the test results carried out above, the Pre-Test and Post-test increased from 15 students with a Mean Rank of 8.00 and Sum Of Rank 120.00.

Table 6. Test Statistics[a]

	posttest - pretest
Z	-3.413[b]
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Based on the table above, a significance value of 0.000 is obtained, which means that it is less than the significance level (α) of 0.05, so H_0 is rejected. This means that there is a significant difference between pre-test and post-test scores. Therefore, it can be concluded that the contextual teaching learning model assisted by PhET simulation media has a positive effect on the ability of higher-order thinking skills of grade IV students of SD Islam ATS Tsiqoh Palangka Raya.

Conclusion

The application of the contextual teaching learning model assisted by PhET simulation media in IPAS subjects consists of 7 stages, namely introduction of material (constructivism), inquiry, discussion and question and answer (questioning), learning community (learning community), modelling (modelling), reflection and authentic analysis. This meeting was held for 3 meetings with three observers. The score obtained from the overall observation results was 87.5% in the satisfactory category. The results of the effectiveness of the pretest, posttest, normality test and hypothesis. The average pretest score of 44.00 was obtained, and then after applying the Contextual Teaching and Learning (CTL) learning model using PhET media, it increased to 90.87. The normality test using the Shapiro test obtained a pre-test value of 0.057 > 0.05, so the distribution of data in this pretest was distributed normally. Meanwhile, for the post-test, the results of the higher order thinking skills ability have a value of 0.541 > 0.05 which has a significance, namely the sig > value of 0.05 so that the data in this test is distributed normally. Furthermore, the hypothesis test uses the Wilcoxon Signed Ranks Test with a Mean Rank of 8.00

and a Sum Of Rank of 120.00 with a significance value of 0.000, which means that it is less than the significance level (α) of 0.05, so that H_0 is rejected. This means that there is a significant difference between pre-test and post-test scores. So the Contextual Teaching and Learning model assisted by PhET simulation media is highly recommended to improve Higher-Order Thinking Skills in science education, and can be adapted for wider use.

Author's Contribution

Lisha Marlina: conceptualization, design of the study, data collection, data analysis, and drafting of the manuscript. Gito Supriadi: provided supervision and critical review of the manuscript. Setria Utama Rizal: assisted in data interpretation, literature review, and helped revise the manuscript.

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