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Students' Conceptual Understanding of Alternative Energy Material After RADEC Model Learning in Grade IV Elementary School

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Abstract. The importance of understanding the concept of alternative energy for elementary school students cannot be separated from the current global conditions. The RADEC learning model is a learning approach designed to improve students' understanding of concepts in different ways. The objectives of this study are 1) to determine the differences in students' learning outcomes in understanding the concept of alternative energy functions using the RADEC learning model in sixth grade. 2) To obtain a learning model that provides better learning outcomes in the subject of alternative energy functions in sixth grade elementary school. The research design used in this study is a quasi-experiment with a nonequivalent control group design. The population of this study was all sixth-grade elementary school students. The instruments used in this study included descriptive tests and observation sheets. The instruments used in this study were test questions adjusted to the revised Bloom's taxonomy understanding indicators. The results of data analysis showed that the RADEC learning model had a significant effect on improving students' conceptual understanding. Normality and homogeneity tests ensured that the data met the assumptions of parametric statistical analysis. The Paired Sample T-Test showed a significant increase in the pretest and posttest of both groups, with a greater increase in the experimental group. The Independent Sample T-Test revealed a significant difference between the two groups in the posttest (Sig. 0.003 < 0.05). The N-Gain analysis showed an average increase in understanding of 46.41% in the experimental group, higher than the control group at 30.15%. This study concluded that the RADEC model was more effective than the STEM method in improving students' understanding of alternative energy concepts.

Keywords: Learning Model, RADEC, Conceptual Understanding, Elementary School..

INTRODUCTION

Education is a conscious and planned effort to create a learning process that can nurture students' potential in cognitive, psychomotor, and affective aspects (Rahman et al., 2022). One of the roles of education is to bridge the transfer of knowledge and skills from generation to generation, both through formal and informal teaching (Sumia et al., 2025). At the elementary school level, education serves not only as a means of character building but also as a foundation for students to develop an understanding of basic concepts necessary in everyday life (Hakim, 2023). In the educational process, the success of achieving learning objectives depends on careful learning planning, which is outlined in the form of a learning implementation plan document (Frandani et al., 2025). This plan is designed to guide an effective learning process so that students are able to develop the skills needed in society, the nation, and the state, in accordance with Article 1 of Law No. 20 of 2003 on the National Education System.

Learning about alternative energy for students is included in the fourth grade of elementary school, where there are indicators of the urgency of this subject matter. In the independent curriculum, at the end of Phase B, students must have the ability to understand the

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characteristics of living things; the forms of matter and its changes; energy and its changes. Where students understand the characteristics of energy and its changes, material on alternative energy is integrated. According to Nugroho et al., (2019), alternative energy, also known as renewable energy, is a type of energy that comes from natural resources such as rain, wind, geothermal heat, heat, tidal water, and the sun. These energy sources are environmentally friendly and do not cause negative impacts such as global warming or climate change caused by high levels of carbon dioxide. Conceptual understanding is the foundation for designing inquiry-based, project-based, and discussion-based learning that encourages students to construct, connect, and apply concepts, as well as for developing assessments that measure deep understanding rather than mere memorization (Zakiah & Tatang, 1907). The importance of understanding the concept of alternative energy for elementary school students is inseparable from the current global conditions , where according to Puspita & Nugraheni, (2024) energy needs continue to increase, while fossil energy reserves such as oil, gas, and coal are running low. This excessive dependence on fossil fuels has a negative impact on the environment, such as increased carbon emissions, pollution, and global warming, which pose a serious threat to the survival of future generations (Maryam et al., 2024).

RADEC is a learning model that guides students through the stages of reading sources (Read), answering trigger questions (Answer), discussing answers (Discuss), explaining again (Explain), and producing products (Create). This model is student-centered and emphasizes the process of actively, collaboratively, and reflectively constructing knowledge, rather than simply receiving explanations from the teacher. Therefore, RADEC was chosen as the learning model in this study. The RADEC (Read, Answer, Discuss, Explain, Create) and STEM (Science, Technology, Engineering, and Mathematics) learning models are two learning models designed to improve students' conceptual understanding in different ways. The RADEC model emphasizes critical thinking and collaborative discussion, which are expected to help students understand alternative energy concepts in depth and encourage them to implement or create based on their understanding. According to Apriansah et al., (2024), RADEC learning can be said to be effective in improving the quality of learning in accordance with Indonesian teaching needs, the syntax of which is reading, answering, discussing, explaining, and creating. On the other hand, the STEM model utilizes a project-based approach that allows students to integrate their knowledge in real-life contexts by integrating Science, Technology, Engineering, and Mathematics (Aureola Dywan et al., 2020). Both models have been proven to influence students' understanding of alternative energy in sixth grade elementary school, as evidenced by previous studies.

This study aims to determine whether there is a significant difference in students' understanding of alternative energy concepts between those taught using the RADEC learning model (Read, Answer, Discuss, Explain, and Create) and those taught using the STEM learning model (Science, Technology, Engineering, and Mathematics). Both models are innovative approaches designed to promote active, student-centered learning and deepen conceptual understanding. However, each has different emphases the RADEC model focuses on developing critical thinking, collaboration, and creativity through structured stages of reading, discussion, explanation, and creation, while the STEM model integrates interdisciplinary knowledge to solve realworld problems through scientific inquiry and technological application (Fauziah et al., 2022).

The research is expected to identify which model provides a more effective framework for improving students' conceptual understanding of alternative energy materials topics that are crucial for fostering environmental literacy and energy awareness from an early age. In the current era of global energy challenges and climate change, early education on renewable and alternative energy sources plays a pivotal role in shaping students' attitudes and behaviors toward sustainability.

This study measures the improvement of students' understanding after learning through each model. The results are anticipated to offer valuable insights for teachers and curriculum developers in selecting appropriate learning strategies to enhance science education outcomes. Moreover, the findings may contribute to the broader discourse on integrating innovative models like RADEC and STEM in elementary school classrooms, ensuring that students not only acquire scientific knowledge but also develop higher order thinking skills and problem-solving abilities relevant to the challenges of the 21st century.

METHODOLOGY

The research design used in this study was a quasi-experiment with a nonequivalent control group design. In this design, the experimental and control groups were not selected randomly; both groups were given a pretest and posttest. The inclusion of a control group is because it includes at least two groups of research participants, the group that receives the RADEC learning model intervention and the control group that receives another type of intervention

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(or none at all). Another arrangement may be that one group receives the complete program while the other group receives the usual version of learning activities (Gall et al., 2014).

The research design is presented in the following table.

Kelas	Pretest	Treatment	Posttest
Eksperimen (E)	O_1	X_1	O_2
Kontrol (K)	O_3	X_2	O_4

Tabel 1. *Research Design*

Description:

E : Experimental Class

K : Control Class

O_1 : Pretest results of the experimental class

O_2 : Posttest results of the experimental class

O_3 : Pretest results for the control class

O_4 : Posttest results for the control class

X_1 : Treatment in the experimental class

X_2 : Treatment in the control class

The population of this study was all fourth-grade students at an Islamic elementary school in Purwakarta, which was the location of the study. Samples were taken from two classes with similar characteristics, with each class acting as a treatment group. The sample selection was conducted using purposive sampling so that both classes met the criteria to be used as different treatment groups, namely the group with the RADEC learning process (experimental group) and the group with the STEM learning process (control group).

The instruments used in this study included a post-test to assess students' understanding of alternative energy concepts, consisting of essay questions designed to assess students' understanding after participating in the learning process. In addition, observation sheets were also used to ensure consistency and implementation of the learning process in each class.

Research data were collected through pre-tests and post-tests given to both groups before and after the learning treatment. The pre-test aimed to measure students' initial abilities, while the post-test was used to assess the level of understanding of alternative energy concepts after the application of the RADEC and STEM learning models. In addition, observations were conducted during the learning process to ensure that each model was applied according to the established procedures and syntax.

The data obtained were analyzed quantitatively using descriptive and inferential statistics. Descriptive analysis included calculating the mean, percentage, and gain value to see the increase in learning outcomes in each group (Martias, 2021). Furthermore, parametric statistical tests were conducted through normality and homogeneity tests as prerequisites, followed by a paired sample t-test to test the differences between the pretest and posttest in each group, as well as an independent sample t-test to test the hypothesis of differences between the two groups (Wahyudin, 2023). The N-Gain test was used to determine the level of improvement in students' conceptual understanding more specifically (Triyono et al., 2024).

RESULTS AND DISCUSSION

This study aims to analyze the effect of the RADEC learning model on the conceptual understanding of sixth-grade students at an Islamic elementary school in Purwakarta on the subject of alternative energy. The data analysis process involved several tests, including normality tests, paired sample t-tests, homogeneity tests, independent sample t-tests, N-Gain tests, and effect size tests used to evaluate the level of creativity of students in the experimental class. Before testing the hypothesis, the researcher conducted prerequisite tests, including normality and homogeneity tests. The normality test was used to determine the data distribution, while the homogeneity test was used to ensure the similarity of variance between groups. The results of both tests can be seen in the table.

Jenis Uji	Data	Statistik	df	Sig.	Keterangan
Normalitas (*Shapiro-Wilk*)	Pretest Eksperimen	0.938	15	0.355	Normal
	Posttest Eksperimen	0.907	15	0.120	Normal

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	Pretest Kontrol	0.886	15	0.057	Normal
	Posttest Kontrol	0.897	15	0.086	Normal
Homogenitas (*Levene's Test*)	Posttest Eksperimen & Kontrol	2.297	3;7	0.165	Homogen

Tabel 2. *Normality & Homogeneity Test*

The results of the normality test using the Shapiro-Wilk method indicate that all data meet the normality assumption. For the pretest in the experimental group, the Shapiro-Wilk statistic value was 0.938 with a significance value of 0.355, indicating that the data was normally distributed because the Sig. value was > 0.05. Similarly, the posttest in the experimental group had a statistic value of 0.907 with a Sig. value > 0.120, which also met the normality assumption. In the control group, the pretest had a statistical value of 0.886 with a Sig. value of 0.057, while the posttest had a statistical value of 0.897 with a Sig. value of 0.086. Both results indicate that the data in the control group is also normally distributed. With thus, all data meets the assumption of normality, so it can be used in parametric statistical analysis.

The homogeneity test was conducted to ensure the similarity of variance between the data groups being compared. The results of the variance homogeneity test using Levene's Test showed that the variance of the Posttest data in the experimental group was homogeneous. This was indicated by a Levene Statistic value of 2.297 with a group degree of freedom (df1) of 3 and an error degree of freedom (df2) of 7. The significance value (Sig.) produced is 0.165, > 0.05. Thus, there is no significant difference in variance between groups, so the assumption of variance homogeneity is fulfilled. Fulfillment of this assumption indicates that the data can be used for parametric statistical analysis.

The paired sample t-test was used to examine the difference between the pretest and posttest scores in both groups, the experimental and control groups.

Paired samples Test				
Paired Differences			Significance	
95% Confidence Interval of the Difference	t	df	One-Sided p	Two-Sided p

		Lower	Upper				
Pair 1	Pretest X (Eksperimen) - Posttest X (Eksperimen)	-24.918	-12.815	-6.687	14	<,001	<,001
Pair 2	Pretest Y (Kontrol) - Posttest Y (Kontrol)	-16.575	-8.092	-6.236	14	<,001	<,001

Table 3. *Paired Samples t-test*

The results of the Paired Samples t-test show a significant difference between the pretest and posttest scores in both groups, both the experimental and control groups. In the experimental group (Pair 1), the average score difference was -18.867, with a t-value of -6.687 and a p-value (< 0.001), indicating a highly significant result. The 95% confidence interval range for the score difference was between -24.918 and -12.815, indicating that the posttest scores were higher than the pretest scores.

In the control group (Pair 2), the average score difference was -12.333, with a t-value of -6.236 and a p-value (< 0.001), which also showed highly significant results. The 95% confidence interval range for the score difference was between -16.575 and -8.092, which also showed an increase in posttest scores compared to pretest scores. Overall, both groups experienced significant improvement after the treatment. However, the experimental group had a larger average difference than the control group, which may indicate that the treatment given to the experimental group had a greater impact on the pretest and posttest results.

Next, we tested the research hypothesis, where the description of the research hypothesis and statistical hypothesis are as follows.

Ho: There is no significant difference between students' conceptual understanding of Alternative Energy material in grade VI who applied the RADEC learning model and students' conceptual understanding of Alternative Energy material in grade VI who applied the STEM learning model.

Ha: There is a significant difference between students' conceptual understanding of the Alternative Energy material in grade VI applying the RADEC learning model and

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students' conceptual understanding of the Alternative Energy material in grade VI applying the STEM learning model.

The statistical hypothesis is as follows.

$$Ho : \mu_1 = \mu_2$$

$$Ha : \mu_1 \neq \mu_2$$

The basis for decision making in the independent sample T-test is that if the Significance value (2-tailed) is < 0.05, then Ho is rejected and Ha is accepted, whereas if the Significance value (2-tailed) is > 0.05, then Ho is accepted and Ha is rejected. The results of the research hypothesis test with the independent sample T-test are as follows.

Independent Samples Test

		t-test for Equality of Means	
		Significance	
		One-Sided p	Two-Sided p
Pemahaman Konsep	Equal variances assumed	.001	.003

Table 4. *Independent Samples Test*

In the row Equal variances assumed, the Sig. (Two-Tailed) value is 0.003 (< 0.05). Because Sig. (Two-Tailed) < 0.05, Ho is rejected and Ha is accepted. This means that there is a significant difference between the conceptual understanding of students who apply the RADEC learning model and students who apply the STEM learning model. The analysis results show that the RADEC and STEM learning models produce significant differences in students' conceptual understanding of Alternative Energy material.

The next data analysis is the N-gain test, which is used to analyze the average increase in conceptual understanding between classes that apply the RADEC learning model and classes that use the STEM learning model. The N-Gain test results are presented in the following table.

	Kelas Eksperimen	Kelas Kontrol
	N-Gain (%)	N-Gain (%)
Rata-rata	46,41	30,15
Minimum	0	0

Maksimum	70	54,76

Table 5. *N-Gain Test*

The N-Gain test results show that the experimental class, which used the RADEC learning model, had an average increase in concept understanding of 46.41%, higher than the control class, which used the STEM learning method with an average of 30.15%. In the experimental class, the increase in concept understanding ranged from 0% to 70%, while in the control class it ranged from 0% to 54.76%. This indicates that the RADEC learning model is more effective in improving students' concept understanding than the STEM learning method in this study. In addition, the higher maximum score range in the experimental class shows greater potential for success in improving student understanding through the RADEC learning model.

The RADEC learning model is an innovative alternative developed from the inquiry learning model, designed to meet the needs of education in Indonesia (Sopandi, 2021). This model was first introduced by Sopandi at an international seminar in Malaysia in 2017. The name RADEC is derived from the stages of learning activities that form its core syntax: reading, answering, discussing, explaining, and creating works. This model is designed to encourage students to engage in various learning activities, such as reading, taking notes, explaining concepts, solving problems, and producing work (Magdalena et al., 2021; Ratnasari & Sukmawati, 2023; Tulljanah & Amini, 2021). The advantages of RADEC lie in its ease of implementation, both by teachers and students, as well as its ability to support learning at the primary and secondary education levels. In addition, this approach is considered relevant to the needs of the 21st century, which demands the mastery of critical competencies in a relatively short time. This model is designed to improve students' conceptual understanding and creativity (Rindiana et al., 2022).

This study aims to determine the differences in students' conceptual understanding learning outcomes on alternative energy function material using the RADEC learning model in sixth grade and to obtain a learning model that provides better learning outcomes on alternative energy function material in sixth grade elementary school. The research instruments were validated beforehand to ensure their suitability (Matondang, 2009). After validation, the research was conducted by comparing data from the experimental group using RADEC and the control group using STEM learning. The data obtained was then analyzed to identify the effect of the RADEC model on students' conceptual understanding learning outcomes.

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The results showed that the RADEC learning model had a significant effect on improving students' conceptual understanding compared to the STEM learning method. The Shapiro-Wilk normality test confirmed that the data from both groups (experimental and control) were normally distributed, allowing for parametric statistical analysis. The homogeneity of variance test showed that the variance of the two groups was homogeneous, supporting the validity of further testing for parametric statistical analysis.

The Paired Sample T-Test showed a significant increase between the pretest and posttest in both groups. However, the experimental group experienced a greater average increase (-18.867) than the control group (-12.333), indicating the effectiveness of the RADEC model. Furthermore, the Independent Sample T-Test revealed a significant difference between the two groups on the posttest (Sig. 0.003 < 0.05), confirming that RADEC learning provides better results than STEM. The N-Gain analysis reinforced these findings, with an average increase in concept understanding of 46.41% in the experimental class, higher than the 30.15% in the control class. The higher maximum score range in the experimental class (70% - 54.76%) indicates the potential success of RADEC in improving student understanding. Overall, the RADEC model proved to be more effective in promoting students' conceptual understanding of alternative energy material.

CONCLUSION

Based on the results of the study, the RADEC learning model proved to be effective in improving sixth-grade students’ understanding of alternative energy concepts compared to the STEM learning model. The normality test indicated that the data were normally distributed, and the homogeneity test confirmed that the variances between groups were homogeneous, allowing for parametric statistical analysis. The results of the Paired Sample T-Test showed a significant improvement in students’ conceptual understanding in both the experimental and control groups, with a greater increase observed in the experimental group.

Furthermore, the Independent Sample T-Test revealed a significant difference between the two groups, confirming the superiority of the RADEC model in enhancing students’ conceptual understanding. The N-Gain analysis further supported this finding, showing a higher average gain in the experimental group compared to the control group. These results suggest that the RADEC learning model can be relied upon as an innovative and effective approach to improving student learning outcomes, particularly in topics related to alternative energy. This study highlights the potential of RADEC to foster deeper understanding, critical thinking, and creativity among students while promoting environmental awareness and energy literacy from an early age. Thus, RADEC offers valuable implications for effective science learning strategies in elementary education.

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