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Radec Model : Improving Elementary Students' Environmental Care And Science Literacy Through Energy Source Materials

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ABSTRACT: This study investigates the impact of the RADEC (Read, Answer, Discuss, Explain, and Create) learning model on scientific literacy skills and environmental care character among 4th-grade elementary students in Indonesia. Using a quasi-experimental design with pretest-posttest control group, the research focused on energy source materials. The experimental group received RADEC instruction, while the control group used Problem-Based Learning. Results showed significant improvements in scientific literacy across all indicators (explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and scientific evidence) for the RADEC group. Similarly, students' environmental care character enhanced in various aspects, including school and classroom environment management, waste and energy management, and planning clean environment programs. The RADEC model's structured approach, emphasizing independent exploration and critical thinking, proved more effective than traditional methods in fostering scientific literacy and environmental awareness. The study concludes that RADEC offers a promising framework for enhancing science education and environmental consciousness in elementary schools, with implications for curriculum development and teaching practices in the context of 21st-century skills and digital literacy.
Keywords: RADEC learning model; scientific literacy; environmental care; elementary education; energy sources; quasi-experimental design; Problem-Based Learning; 21st-century skills

Abstrak: Penelitian ini bertujuan untuk mengetahui dampak model pembelajaran RADEC (Read, Answer, Discuss, Explain, and Create) terhadap keterampilan literasi sains dan karakter peduli lingkungan pada siswa kelas 4 SD di Indonesia. Menggunakan desain quasi eksperimen dengan pretest-posttest control group, penelitian difokuskan pada materi sumber energi. Kelompok eksperimen mendapat pembelajaran RADEC, sedangkan kelompok kontrol menggunakan Pembelajaran Berbasis Masalah. Hasilnya menunjukkan peningkatan yang signifikan dalam literasi sains di seluruh indikator (menjelaskan fenomena secara ilmiah, mengevaluasi dan merancang penyelidikan ilmiah, dan menafsirkan data dan bukti ilmiah) pada kelompok RADEC. Begitu pula dengan peningkatan karakter peduli lingkungan siswa dalam berbagai aspek, antara lain pengelolaan lingkungan sekolah dan kelas, pengelolaan limbah dan energi, serta perencanaan program lingkungan bersih. Pendekatan terstruktur model RADEC, yang menekankan eksplorasi mandiri dan pemikiran kritis, terbukti lebih efektif dibandingkan metode tradisional dalam menumbuhkan literasi sains dan kesadaran lingkungan. Studi ini menyimpulkan bahwa RADEC menawarkan kerangka kerja yang menjanjikan untuk meningkatkan pendidikan sains dan kesadaran lingkungan di sekolah dasar, dengan implikasi terhadap pengembangan kurikulum dan praktik pengajaran dalam konteks keterampilan abad ke-21 dan literasi digital.
Kata-kata Kunci: Model pembelajaran RADEC, literasi sains, kepedulian lingkungan, pendidikan dasar, sumber energi, eksperimen kuasi, pembelajaran berbasis masalah, keterampilan abad 21

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INTRODUCTION

In the current information age, scientific literacy plays an increasingly crucial role in daily life. A scientifically literate society has advantages in making intelligent decisions and participating more effectively in science and technology issues. Scientific literacy is considered one of the keys to facing various challenges in the 21st century, as mastery of basic science and technology concepts greatly aids in solving life's problems. However, this doesn't mean everyone must become a science expert; having and mastering basic science concepts enables individuals to make choices that impact their lives.

Unfortunately, students' scientific literacy in Indonesia is still not encouraging. This is based on survey results from TIMSS (Trends in International Mathematics and Science Study) in 2015, where Indonesia ranked fourth lowest out of 47 participating countries (Mullis, et al., 2006). Similarly, the PISA (Programme for International Student Assessment) survey conducted by The Organisation for Economic Co-Operation and Development (OECD) in 2018 revealed that Indonesian students have low levels of scientific literacy compared to other countries (OECD, 2019). These findings broadly represent the general condition of scientific literacy skills among elementary school students. Several studies have shown that elementary students' scientific literacy skills are still at a low level (Utami, et al., 2022).

Scientific literacy is closely related to an individual's character in developing a more caring or sensitive attitude towards the environment. A correlational study attempting to reveal the relationship between scientific literacy and environmental awareness among junior high school students found that scientific literacy has a positive relationship with students' environmental care attitudes (Suhartinah, et al., 2019). If students' level of scientific literacy is good, their attitude of care towards the environment will also be good.

The causes of low scientific literacy and environmental care attitudes among students include the use of inappropriate approaches, methods, strategies, and learning models, teacher-centered learning, and a lack of orientation towards the process of forming environmental care characters (Boateng, C. A., Boateng, S. D., 2015). Research examining scientific literacy and environmental care attitudes in science learning has been widely conducted, with some applying various methods, models, and learning tools using diverse designs and research subjects (Lestari, et al., 2021).

To address these issues, the research proposes implementing the RADEC (Read, Answer, Discuss, Explain, and Create) learning model. This model, developed by Sopandi W, is based on constructivist learning theory and focuses on developing 21st-century skills, including HOTS (High Order Thinking Skills), multiliteracy, and character education. The RADEC model's profile and characteristics make it a potential solution to help teachers develop students' scientific literacy and environmental care attitudes in their classrooms (Sopandi, 2017).

The study aims to implement the RADEC model to improve scientific literacy and environmental care character in elementary school students, specifically focusing on energy source materials. This research is considered innovative as it applies the RADEC model to scientific literacy and environmental care in a new context, addressing a research gap in the field of science education at the elementary level. The research will be conducted in an elementary school in Bogor Regency, synthesizing the latest theories in the field. By addressing the low levels of scientific literacy and environmental care, this study seeks to create an ideal science learning situation capable of meeting global challenges and preparing students for future competitiveness.

This hypothesis suggests that the implementation of the RADEC (Read, Answer, Discuss, Explain, and Create) learning model is expected to have a positive impact on students' scientific literacy abilities and their environmental care character. The researchers anticipate that by using this innovative teaching approach, students will show improvements in their understanding and application of scientific concepts, as well as demonstrate increased awareness and concern for environmental issues.

The hypothesis is grounded in the theoretical background and previous studies that have shown the potential of student-centered, active learning approaches in enhancing scientific literacy and fostering positive environmental attitudes. By testing this hypothesis, the study aims to contribute to the growing body of knowledge on effective teaching methods for science education, particularly in the context of elementary school students studying energy source materials

RESEARCH METHOD

A. Research Methods and Design

This research is a quantitative study using a quasi-experimental method. According to Sugiyono (2019), the experimental research method is defined as a way to discover the influence of variables being tested on other variables under controlled conditions. The researcher chose this method due to its alignment with the focus of the study, which is to determine the effect of RADEC learning on scientific literacy and environmental care attitudes of elementary school students.

The experimental research design used is a quasi-experiment with a pretest-posttest control group design. This design compares initial and final tests for both control and experimental groups. The experimental group receives treatment in the form of the RADEC learning model while studying energy source materials. The control group uses the Problem Based Learning model typically employed by teachers in their classes.

The researcher selected this design to identify differences before and after using the RADEC learning model on scientific literacy and environmental care attitudes. Additionally, the study aims to compare scientific literacy and environmental care attitudes between students who received the RADEC learning model treatment and those who did not.

The design allows for a comprehensive comparison of the effects of the RADEC model against traditional teaching methods, providing insights into its effectiveness in improving students' scientific literacy and environmental awareness.

Table 1. Pretest-Posttest Control Group Design

Group	Pretest	Intervention	Post test
Experiment	O_1	X	O_2
Control	O_1	-	O_2

O_1 from the table is a representative of the pretest for the experiment group while O_2 is the representative of post test for this group. X is the treatment group/intervention model RADEC while – is for group with PBL intervention. O_3 and O_4 is the symbol for pretest and post test of the control group respectively.

B. Research Subjects

The research subjects for this study are fourth-grade students from a public elementary school (SDN) in Megamendung District, Bogor Regency. The division of the two classes is based on equal or homogeneous ability levels. In accordance with the research objectives and requirements, these two class groups will be divided into an experimental group and a control group. The experimental group consists of students who will learn using the RADEC learning model, while the control group consists of students who will not use the RADEC learning model.

The sample used in this study was selected using the purposive sampling technique, which is a sampling technique based on specific considerations [11]. This approach allows the researchers to select participants who meet certain criteria relevant to the study's objectives, ensuring that the sample is appropriate for investigating the effects of the RADEC model on scientific literacy and environmental care attitudes.

C. Operational Definitions

This study examines three variables: the application of RADEC as a learning model, scientific literacy, and environmental care attitudes of students in elementary school science learning, focusing on the theme of energy sources. The operational definitions of these variables are:

1. RADEC Learning Model: An innovative learning model easily implemented by teachers, especially in elementary school science education. Its ease of use stems from its memorable syntax that aligns with curriculum demands. The RADEC model consists of five steps: Read (independent reading of print or digital materials), Answer (responding to pre-learning questions), Discuss (discussing pre-learning questions in groups), Explain (presenting agreed-upon group discussion results), and Create (developing creative ideas related to the material, such as product creation, investigation, or problem-solving). In this study, the model's implementation focuses on enhancing scientific literacy and environmental care attitudes in the context of climate change issues.
2. Scientific Literacy: A competency where students can apply their scientific knowledge using scientific methods to solve problems in their environment. It centers on the ability to observe

and interpret natural phenomena, apply scientific skills, and make informed decisions. This ability is measured using a multiple-choice test instrument, assessing three indicators: explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and scientific evidence in elementary school science learning about energy sources.

3. Environmental Care Character: An individual's drive to behave proactively and favorably towards the environment by nurturing, preserving, protecting, preventing, and repairing natural damage. This character is measured using an attitude scale instrument observing three indicators: respect for nature, responsibility, and affection and care for nature.

These operational definitions provide a clear framework for understanding and measuring the key variables in the study, ensuring consistency in the research approach and analysis.

D. Research Intrument and Data Analysis Technique

Table 2 lists research intruments and data analysis techniques that are used in this research.

Table 2. Data Analysis Technique

No.	Data retrieved	Research instrument	Data retrieval technique	Data analysis technique
1.	Science literacy	Written test (Multiple choice)	Pretest dan post test	Quantitative using SPSS
2.	Environmental caring character	Observation sheet	Observation throughout learning process	Descriptive
3.		Questionnaire	Post test	Descriptive
4.	Student's response to RADEC learning model	Survey	Post test	Descriptive

E. Research Procedure

The steps to this research is done in three activities (planning, actuating, collection and analysis of data as well as reporting).

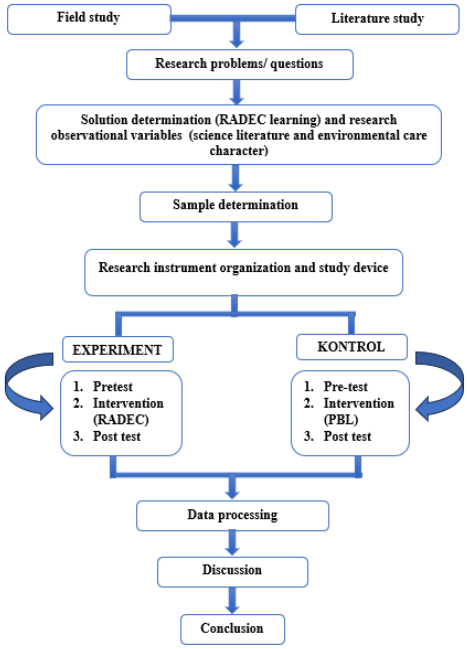

Figure 1. Research procedure flow

FINDINGS AND DISCUSSION

A. Science Literacy of Students Before and After RADEC Learning

This study examines the impact of the RADEC (Read, Answer, Discuss, Explain, and Create)

learning model on students' scientific literacy in elementary school. The research measures scientific literacy through tests based on three indicators: explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and scientific evidence.

Table 3. Descriptive Statistics of Pretest and post test in Science Literacy of Experiment Group

Experiment	N	Min	Max	Mean	SD
Pretest	30	25	65	47.17	13.175
Post test	30	50	90	74.50	10.116
Valid N (listwise)	30				

Initial findings revealed low scientific literacy levels among students in the experimental class. However, after implementing the RADEC model, significant improvements were observed across all indicators. The researchers attribute this improvement to the unique structure of the RADEC model, which encourages active reading, critical thinking, and practical application of knowledge.

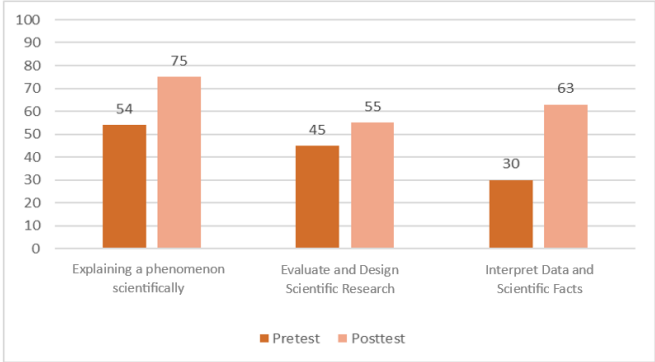

Figure 2. Pretest and Post Test Scores on Experiment Group for Every Science Literacy Indicator

The study highlights several factors contributing to low scientific literacy, including inappropriate teaching methods, misconceptions, lack of contextual learning, and weak reading abilities (Suparyanto dan Rosad, 2020). The RADEC model addresses these issues by fostering reading interest, enhancing reading comprehension, and promoting creativity in problem-solving (Pratiwi, et al., 2018).

Statistical analysis, including normality and homogeneity tests, confirmed the significance of the RADEC model's impact. The paired sample t-test showed a significant difference in students' scientific literacy before and after the RADEC implementation, with a p-value of 0.001 (< 0.05).

The researchers emphasize that RADEC's success lies in its focus on 21st-century skills, higher-order thinking, multiliteracy, and character education. Previous studies have shown RADEC's effectiveness in improving concept mastery across various disciplines (Rohmawatiningsih, et al., 2021).

Furthermore, RADEC creates a contextual, active, and responsive learning environment (Setiawan, 2019). It particularly addresses the issue of poor reading literacy, which is fundamental to scientific literacy development (Kusumaningpuri, 2021).

In conclusion, the study presents strong evidence for the RADEC model as an effective solution to improve scientific literacy among elementary school students, addressing key challenges in science education in Indonesia.

B. Science Literacy of Students Who Study With RADEC Learning and Students Who Do Not Learn With RADEC Learning

This study compared the effectiveness of the RADEC (Read, Answer, Discuss, Explain, and Create) learning model against the Problem-Based Learning (PBL) model in improving students' scientific literacy. The research involved an experimental group using RADEC and a control group using PBL, with both groups studying the same material on energy sources.

Table 4. Descriptive Statistics of Pretest and post test in Science Literacy of Experiment and Control Group

	N	Min	Max	Mean	SD
Pretest (Experiment)	30	25	65	47.17	13.175
Pretest (Control)	30	35	65	55.00	9.002
Post test (Experiment)	30	50	90	74.50	10.116
Post test (Control)	30	50	85	74.83	8.039
Valid N (listwise)	30				

Initial assessments showed that both groups had low scientific literacy levels. However, after the intervention, the experimental group demonstrated significantly better improvement in scientific literacy compared to the control group. This was evident across all three indicators of scientific literacy: explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting scientific data and evidence.

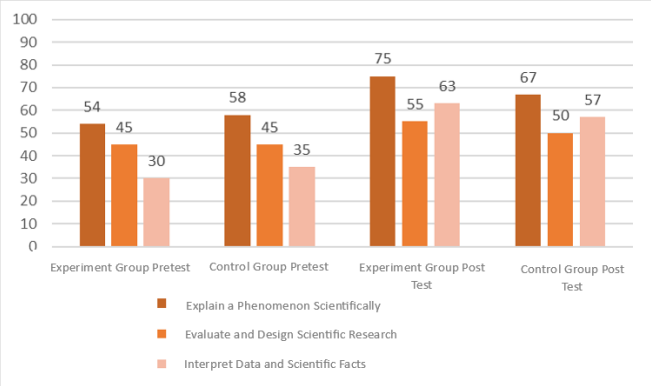

Figure 3. Pretest and Post tst Scores on Expreiment and Control Group on Every Science Literacy Indicator

The RADEC model proved particularly effective in stimulating students' curiosity and encouraging them to explore scientific phenomena related to the lesson content. It also provided opportunities for students to discuss and communicate their ideas about scientific investigations, going beyond mere concept understanding to enable students to design investigations and construct their own knowledge (Nbina & Obomanu, 2010).

Statistical analysis, including normality and homogeneity tests, confirmed the significance of these findings. The independent sample t-test showed a significant difference ($p < 0.05$) between the RADEC and PBL groups, with RADEC proving more effective in enhancing scientific literacy.

The RADEC model's success is attributed to its focus on problem-solving orientation[20] and its ability to develop critical thinking, communication skills, cooperation, and creative thinking. This aligns with the view that developing scientific literacy requires learning strategies that foster higher-order thinking skills and problem-solving through a multidisciplinary approach (Arisanti, et al., 2017).

Furthermore, RADEC addresses the issue of low scientific literacy caused by learning processes that only develop memorization skills. It provides students with opportunities to apply their scientific knowledge to real-world problems (Purnomo, 2021). This practical application of knowledge is crucial in developing students' ability to identify natural phenomena from a scientific perspective and determine their role and actions accordingly (Hayati, 2017).

In conclusion, the study provides strong evidence for the superiority of the RADEC model over traditional PBL in enhancing scientific literacy among elementary school students, particularly in the context of energy source education.

C. Student's Environmental Caring Character

This study examined the impact of the RADEC (Read, Answer, Discuss, Explain, and Create) learning model on students' environmental care character. The research measured environmental care through a questionnaire based on five aspects: school environment management, classroom environment maintenance, waste management, energy management, and planning clean environment programs.

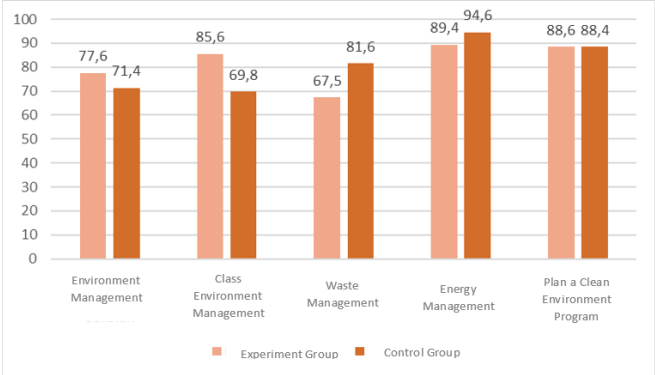

Figure 4. Post-test Score of Experiment and Control Class on Every Aspect of Environmental Caring Character

Observations during the learning process revealed that students who cared for the environment demonstrated behaviors reflecting their concern for environmental sustainability. They actively participated in eco-friendly activities, adopted environmentally responsible habits, and showed responsible attitudes towards resource use. Students consistently separated organic and inorganic waste, used reusable water bottles and cloth bags, and practiced energy efficiency by turning off unused electrical appliances. Many students also chose to walk or cycle to school when possible.

Table 5. Grading Criteria for Environmental Caring Character in Students

Interval	Criteria
0%-19.99%	Very poor
20%-39.99%	Poor
40%-59.99%	Average
60%-79.99%	Good
80%-100%	Very good

The study found that students in the experimental group (RADEC) showed higher levels of environmental care compared to the control group. This was attributed to the RADEC model's emphasis on exploring environmental knowledge through reading activities, which increased students' awareness and motivation to appreciate, care for, and protect the environment (Faizah, 2020).

Statistical analysis of the post-test results showed that students' environmental care character was in the "good" category, with a percentage of 70%. This indicates that while students had developed a satisfactory level of environmental care, there was still room for improvement.

The RADEC model proved effective in developing students' environmental care character by integrating character education with environmental awareness. This aligns with previous research suggesting that environmental-based learning can teach students about ethical behavior towards nature (Landriany, 2014). The model's structure, particularly the Read and Answer steps, helped reinforce students' understanding of environmental concepts, addressing misconceptions that often lead to low environmental care.

The Discuss and Explain steps of RADEC provided opportunities for students to collaborate and understand environmental issues better. This approach is supported by research recommending activities such as exploring various information sources, discussing current environmental issues, and developing investigations about these issues to enhance environmental awareness (Veselinovska & Kirova, 2013).

Finally, the Create step allowed students to demonstrate their environmental care through practical actions, aligning with the definition of environmental care attitudes as actions taken to preserve, maintain, and manage nature by preventing and repairing damage (Azhar, 2016).

In conclusion, the study provides evidence that the RADEC learning model can effectively develop students' environmental care character, offering a promising approach to environmental education in elementary schools. In conclusion, the study provides evidence that the RADEC learning model can effectively develop students' environmental care character, offering a promising approach to environmental education in elementary schools.

CONCLUSION

The RADEC learning model has shown a significant positive impact on 4th-grade elementary students' scientific literacy skills and environmental care character. Research findings indicate marked improvements in students' ability to explain scientific phenomena, evaluate and design scientific investigations, and interpret scientific data and evidence after implementing RADEC in energy source lessons. Similarly, students' environmental care character enhanced across various aspects, including school and classroom environment management, waste and energy management, and planning clean environment programs. The model's effectiveness is attributed to its structured approach, comprising Read, Answer, Discuss, Explain, and Create stages, which facilitate independent exploration of concepts prior to class sessions.

The implications of this research highlight RADEC's potential to enhance scientific literacy and environmental awareness across various scientific fields, particularly in science education. Its step-by-step approach provides a framework that is easily understood and applied by both teachers and students, fostering an independent, active, collaborative, and creative learning environment. Moreover, RADEC has been observed to boost students' motivation and critical thinking, encouraging scientific inquiry and real-world problem-solving skills.

For optimal implementation, several recommendations are proposed. Educators should consider the nature of the concepts being taught when applying RADEC, as its effectiveness may vary depending on the subject matter. Pre-learning questions should be tailored to students' language proficiency and include relevant Indonesian-centric examples. Strong collaboration between teachers and parents is also emphasized to ensure effective implementation. Lastly, given the rapid pace of technological advancement, integrating RADEC with digital literacy and reinforcing Indonesian social character is suggested as a promising direction for future development, potentially contributing to more relevant and effective learning processes in the digital era.

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