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Enhancing Higher-Order Thinking Skills in Elementary Science Learning Using the RADEC Model

Shinta Sunny Oktadila[1*], Hadi Nasbey[2], Indra Jaya[3]

[1] Faculty of Education, Universitas Negeri Jakarta, Jakarta, Indonesia
[2] Faculty of Mathematics and Science, Universitas Negeri Jakarta, Jakarta, Indonesia
[3] Faculty of Education, Universitas Negeri Jakarta, Jakarta, Indonesia

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Corresponding Author:
Shinta Sunny Oktadila
shintasunnyoktadila@gmail.com

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Abstract: This study aims to determine the effectiveness of the RADEC (Read, Answer, Discuss, Explain, and Create) learning model in improving Higher Order Thinking Skills (HOTS) in science learning of fifth grade elementary school students in Palembang City. This study used an experimental method with a posttest-only control group design. This study involved 48 fifth grade elementary school students in Palembang City who were divided into experimental groups (n = 24) and control groups (n = 24). Data collection was carried out through a HOTS Science test on the material Magnets, Electricity, and Technology for Life. The form of questions used, namely multiple-choice questions and essay questions, has been tested for validity and reliability. The results of the analysis using the t-test showed that there was a significant effect of the RADEC model on improving students' HOTS (sig. 0.028 <0.05). The average HOTS post-test score of the experimental class was higher than the control class (76.96 > 68.25). The findings of the study indicate that RADEC can be implemented as an alternative learning strategy to improve HOTS in elementary science learning.

Keywords: 21st-century learning; Higher-order thinking skills; RADEC; Science learning

Introduction

The development of 21st-century education requires students to master Higher Order Thinking Skills (HOTS), which include critical thinking, creativity, communication, and collaboration skills (Aryana et al., 2022). HOTS includes skills in critical, creative, analytical thinking, as well as the ability to solve problems and make decisions (Arafah et al., 2021). In the context of learning at the elementary school level, the application of HOTS is very important to help students understand concepts more deeply, not just memorizing information, so that they are better prepared to face challenges in real life (Ichsan et al., 2022).

One of the subjects that contributes to the development of HOTS is Natural Sciences (IPA). Science learning requires students to observe, analyze, and conclude natural phenomena scientifically (Kusumawati, 2022). According to Wardani et al. (2021), so far, teaching in schools carried out by teachers has focused more on convergent thinking processes. This results in a lack of stimulation of divergent thinking processes, such as the ability to think creatively in solving problems by producing various possible answers from different points of view. This makes it difficult for students to apply the knowledge they have to solve everyday problems. Therefore, innovation is needed in learning methods that can improve students' HOTS skills.

The learning approach that can be used to improve HOTS in science learning is the Read, Answer, Discuss, Explain, and Create (RADEC) model. The RADEC learning model is a learning strategy that can be implemented in science learning through the Read,

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Answer, Discuss, Explain and Create stages (Hana Lestari, 2022). The RADEC model is designed to actively involve students in the learning process through five stages: reading, answering, asking, discussing, explaining, and creating (Sukardi et al., 2021). With this approach, students are invited to think more deeply, develop analytical skills, and find creative solutions in learning.

This model also creates a more interactive and enjoyable learning atmosphere, so that it can increase students' learning motivation (Suryana et al., 2021). The RADEC learning model is also an alternative that can be used by teachers with syntax that is easy to remember and apply, and supporting factors include a curriculum that encourages the development of student potential, the availability of information sources, and the need for 21st century skills (Setiawan et al., 2022). The RADEC learning model is student-oriented by involving a series of activities, such as understanding concepts, collaborating, solving problems, and creating a work or idea (Herianingtyas et al., 2023).

In addition, the RADEC model can also increase student independence, strengthen 4C skills (communication, collaboration, creativity, and problem solving), as well as train self-confidence, increase interest in reading, and encourage active participation in learning (Nurliana & Sukmawati, 2023). By focusing on student involvement, this model allows them to participate actively, so that the learning experience becomes more meaningful and profound (Nurjannah et al., 2023). According to Sopandi et al. (2021), the RADEC model can increase students' interest in reading and encourage them to be more active in the learning process.

The superiority of this model is also proven through a number of studies conducted by Maspiroh and Sartono (2022) showing that the RADEC model is more effective in improving students' HOTS compared to the inquiry learning model. In addition, research by Wahyuni et al. (2022) revealed that the RADEC model is more effective than Discovery Learning in improving science process skills and science learning outcomes of fifth grade students, because this model actively involves students, while Discovery Learning tends to be less effective in increasing student participation due to the lack of direct direction from the teacher. Another study conducted by Yulisdiva et al. (2023) showed that the high-level thinking skills of students who used the RADEC model were better than students who used the inquiry model in learning science on the subject of force in elementary schools.

Several studies above show that the RADEC learning model is more effective in improving higher-order thinking skills (HOTS), science process skills, and student learning outcomes. Therefore, the main objective of this study is to determine the effectiveness of using the Read, Answer, Discuss, Explain, and Create (RADEC) model in improving Higher-Order Thinking Skills (HOTS) in science learning. Through the RADEC model, it is expected that students can be actively involved in the learning process, develop deep thinking skills, and find creative solutions in dealing with various problems, so that they are better prepared to face challenges in real life and improve the quality of science learning at the elementary school level.

Method

This study is a quantitative study using an experimental method by comparing two learning models. The experimental method is a study that tests the causal relationship between independent variables and dependent variables through certain treatments and observations of the results (Hamilton et al., 2021). The experimental design used in this study is a post-test only control group design, where the experimental class group is given treatment and the control group does not receive treatment. The structure of this research design can be described in Table 1.

Table 1. Design Experimental

Group	Action	Posttest
R	X	O_1
R	-	O_2

The population in this study were fifth grade students at public elementary schools in Ilir Barat I sub-district, Palembang City. Furthermore, the sample was selected using the probability sampling method with the simple random sampling technique. The simple random sampling technique is a random sample selection without considering stratification (Sahir, 2021). In this study, the sample was selected through a lottery system and selected Public Elementary School 21 Palembang as the research location.

The learning materials studied by students are Magnets, Electricity, and Technology for Life. The test instrument used is HOTS Science questions in the form of 11 multiple-choice questions and 6 essay questions. This test aims to measure students' HOTS abilities after being given treatment. Then, the results of the students' posttest are measured using the t-test.

Data collection in the form of a post-test was given after students studied the material Magnets, Electricity, and Technology for Life. Data analysis was measured by a t-test which aims to determine whether there are differences in test results in the experimental and control groups. Data analysis in this study used the help of the SPSS 27 Program. Before the questions were given to the research subjects, the questions were first tested in a class that was not a research sample. The trial aims to determine the validity and reliability of the questions. Then, the validity and reliability of the HOTS instrument were calculated to ensure that the measuring instrument used to measure Higher-Order Thinking Skills (HOTS) skills provides consistent and reliable results. The researcher used 15 multiple-choice questions and 6 essay questions. The results of the study showed that 11 multiple-choice questions were valid and reliable. While in essay questions, 6 questions were valid and reliable.

Validity Test

Based on the r product moment table at a significance of 5%, it was obtained 0.361. The results of the validity test of invalid multiple-choice questions are listed in Table 2.

Table 2. Validity Test

Multiple Choice Question Items	r-count	Description
1	0.128	Invalid
8	0.197	Invalid
12	0.297	Invalid
14	0.077	Invalid

Based on the table above, it can be seen that 4 of the 15 multiple-choice questions are invalid, while all descriptive questions are valid.

Reliability Test

The reliability test of the items was declared valid, which amounted to 17 questions consisting of 11 multiple-choice questions and 6 essay questions. The results of the reliability test can be seen in Table 3.

Table 3. Reliability Statistics

Cronbach's Alpha	N of Items
0.730	17

As indicated in Table 3, a Cronbach's Alpha value of 0.730 was obtained, demonstrating the reliability of the 17-item instrument.

Result and Discussion

Before analyzing the data, the researcher conducted a normality and homogeneity test as a prerequisite test using SPSS program 27 software. The normality test in this research was conducted using the One-Sample Kolmogorov-Smirnov Test. Data is considered normally distributed when the significance value exceeds 0.05, otherwise, it is deemed non-normal. The Kolmogorov-Smirnov test yielded a significance value of 0.200 for the experimental group, indicating normal distribution ($p > 0.05$). Similarly, a significance value of 0.113 was obtained for the control group, further confirming the assumption of normality.

Table 4. Tests of Normality

	Kolmogorov-Smirnov[a]		
Class	Statistic	df	Sig.
Experimental Class	.106	24	.200*
Control Class	.160	24	.113

The homogeneity test used is the Levene Statistic, where for valid criteria if the significance is ≥ 0.05 then the group comes from a population that has the same variance. Meanwhile, if the significance value is < 0.05 then the data group comes from a different population. Based on the results of the homogeneity test that has been carried out, it was found that the significance value is 0.488 > 0.05. So, it can be concluded that the data group comes from the same or homogeneous population. The results of the normality test can be seen in Table 5.

Table 5. Test of Homogeneity of Variance

Variable	Sig	Conclusion
HOTS	0.488	Homogeneous

Data analysis was carried out using the t-test and statistical software, namely SPSS program 27. The T-test aims to determine the comparison of the significance value and the post-test result value of students in the experimental class and the control class.

Students in the experimental class were taught using the RADEC model, while the control class used the expository model. After receiving instruction on the topic of Magnets, Electricity, and Technology for Life, students completed a posttest consisting of 11 multiple-choice questions and 6 essay questions. The post-test results were then analyzed using a t-test to determine whether the learning model had an impact on the higher-order thinking skills (HOTS) of grade V students. The t-test results are presented in the table below.

Table 6. T-Test Results

		t-test for Equality of Means		
		t	df	Sig. (2-tailed)
HOTS IPA	Equal variances assumed	2.270	46	0.028

Based on the table above, the T-test results indicate a significance value (2-tailed) of 0.028. Since this value is less than 0.05 ($0.028 < 0.05$), it can be concluded that the learning model has a positive effect on the HOTS in science for grade V students. Further analysis was then conducted to determine whether the HOTS of grade V students using the RADEC model were higher than those using the expository model. The calculation results are presented in Table 7.

Table 7. Descriptive Data Analysis

	Group	N	Mean	Min.	Max.
Posttest	RADEC	24	76.96	49	97
	Expository	24	68.25	49	91

The table above shows that the posttest score of the experimental class is higher than the control class, with an average HOTS IPA of 76.96 > 68.25. This proves that the RADEC model has a significant effect on increasing students' HOTS. The reading, answering, discussing, explaining, and creating (RADEC) model is a learning that can improve students' reading skills and creativity and allow them to discuss with their classmates (Handayani et al., 2019).

The stages of the RADEC model are as follows (Sopandi, 2023): 1) Read, at this stage students search for and analyze information on reading materials from various sources, such as the internet, print media, and so on; 2) Answer, after students search for reading materials from various sources, the teacher then asks questions that can stimulate HOTS skills and students can apply the understanding they already have; 3) Discuss, students are divided into several groups and given LKPD by the teacher to conduct direct experiments and encourage students to express their opinions; 4) Explain, after carrying out discussion activities with group members, group representatives present the results of their discussions or the results of their thoughts in front of the class; 5) Create, students and their group members can conduct direct experiments and draw conclusions from the results of their discussions. Each stage in the RADEC model encourages students to be actively involved, develop, and hone their skills in collaborating, communicating, and understanding concepts (Azis & Asih, 2022; Hernita & Dharma, 2023). This is in accordance with the concept of HOTS skills.

The RADEC model, with its stages (Read, Answer, Discuss, Explain, Create), is designed in accordance with Vygotsky's constructivist principles. In this context, learning is seen as an active process in which students construct their understanding through interaction and collaboration, in line with the ZPD concept (Kusumaningpuri & Fauziati, 2021). Through the stage of reading learning materials before learning activities begin and giving questions, teachers can collect and group the level of difficulty of concepts based on students' answers, so that they can evaluate the extent of their understanding (Lestari & Widodo, 2021). This is in line with research conducted by (Hasibuan et al., 2024), the RADEC model can improve elementary school students' reading comprehension skills. Therefore, the RADEC learning model is in accordance with the needs of education in Indonesia, namely being able to strengthen students' critical thinking skills in the context of local culture, can be adapted for online learning, and has been proven to be more effective than conventional learning models in experimental classes (Fadil & Ramadhan, 2023).

The RADEC model developed based on the education system requires students to understand many scientific concepts with very limited learning time (Sopandi & Handayani, 2019). Therefore, the RADEC learning model can also strengthen student independence by encouraging mastery of 4C competencies (critical thinking, creativity, communication skills, and collaboration that are relevant to 21st century learning (Nurliana & Sukmawati, 2023; Yanti & Suriani, 2024). This is proven based on research conducted by (Yulianti et al., 2022), stating that the RADEC learning model has been proven to significantly improve students' critical thinking skills.

Critical and creative thinking skills play an important role in equipping students to be able to solve problems and make decisions or conclusions that can be accounted for. Critical and creative thinking are forms of higher order thinking skills (Rahmaniah et al., 2023), because both are included in the highest level of cognitive competence that must be mastered by students in the learning process. In learning, the RADEC model shows excellence in facilitating the development of scientific thinking and writing skills, and is able to provide positive encouragement for students who are less motivated (Halim, 2022).

The RADEC model can also improve students' skills to learn independently and master various knowledge in various ways (Iwanda et al., 2022). This is in line with the characteristics of the RADEC Model, namely it can encourage students' critical thinking, by guiding them to interact with useful learning, developing critical thinking skills, connecting knowledge with new material, linking material to everyday life, emphasizing deep understanding through analysis and reflection, and providing opportunities for exploration before learning begins (Pratama et al., 2019). According to Yurniwati and Utomo (2022), critical thinking is defined as a process of learning activities with the competencies needed to create new knowledge. Critical thinking skills include students' skills in assessing information, analyzing, recognizing problems, and making decisions logically and rationally (Jeong & Kim, 2022).

This learning model not only focuses on understanding the theory but also provides opportunities for students to apply their knowledge more meaningfully (Yanti & Suriani, 2024). Student activeness in the learning process helps them develop skills that are relevant to the demands of the times, especially to improve students' HOTS. In this case, this learning model aims to prepare students who need to achieve character, abilities, and develop skills needed in the 21st century. In addition, the RADEC model that encourages mastery of 4C can improve students' HOTS skills and train students' courage to be confident in presenting their work, this is in accordance with the explain stage in RADEC (Tulljanah & Amini, 2021).

According to (Putri & Amini, 2023), the RADEC model contributes to increasing students' learning motivation. In addition, this model is also in line with the established syntax. The RADEC learning model applied by teachers has encouraged students to be more active in learning and developing their potential. Compared to conventional learning, the application of the RADEC model in the experimental class resulted in a significant increase. This suggests that RADEC has succeeded in stimulating students' ability to think critically, solve problems, and innovate, which are the main components of HOTS.

Meanwhile, conventional learning methods in control classes create conditions where students become passive recipients of information. Teachers are more active in delivering material, while students participate less (Andini & Fitria, 2021). The lack of interaction between teachers and students in conventional learning causes students to be passive and only receive knowledge from the teacher, so that their learning motivation is low (Hasnan et al., 2020). This is supported by research by (Agustin et al., 2021), the RADEC learning model has been proven to be more effective in improving students' high-level thinking skills (HOTS) in the Elementary Science Material In-depth course compared to the Inquiry learning model.

Conclusion

Based on the analysis and discussion, it can be concluded that the read, answer, discuss, explain, and create (RADEC) learning model has a significant positive effect on the higher-order thinking skills (HOTS) of fifth-grade students of public elementary schools in Palembang City. This model is more effective than the expository model in improving the higher-order thinking skills (HOTS) of fifth-grade students of public elementary schools in Palembang City. The findings of this study indicate that the RADEC model can be a solution in efforts to improve students' HOTS skills in learning. The generalization of this study is limited because it only focuses on certain schools in public elementary schools in Palembang City. Further research is expected to include more varied samples and explore the RADEC model and other learning models to improve students' HOTS.

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