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# The Effect of the RADEC Learning Model on Elementary School Students' Understanding of Science Concepts

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**ABSTRACT**

*Understanding science concepts is a crucial skill for elementary school students, enabling them to connect and apply these concepts to their daily lives. However, teacher-centered instruction has resulted in suboptimal student understanding of biodiversity concepts. This study aimed to determine the impact of the RADEC (Read, Answer, Discuss, Explain, and Create) learning model on the science concept understanding of fifth-grade elementary students regarding biodiversity. A quantitative approach was employed using a quasi-experimental method with a non-equivalent control group design. The study population consisted of fifth-grade elementary students during the 2025/2026 academic year. Data were collected via pre-tests and post-tests assessing concept understanding and analyzed using prerequisite tests, an independent sample t-test, and the N-Gain test. The results indicated that the data were normally distributed and homogeneous. The independent sample t-test on post-test scores yielded a significance value of 0.00 ($p < 0.05$), demonstrating a significant effect of the RADEC model on students' science concept understanding. This improvement was supported by an N-Gain score of 0.61 (medium category) and an effectiveness rate of 60.93% (moderately effective category). In conclusion, the RADEC learning model effectively enhances students' science concept understanding through a learning process that fosters independence, collaboration, and creativity. The study recommends the RADEC model as an innovative teaching strategy for elementary schools and suggests it serve as a reference for future researchers looking to adapt the model for different subject matter or educational levels.*

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## 1. INTRODUCTION

Conceptual understanding is a fundamental cognitive ability in elementary school science education, encompassing the capacity to interpret, explain, connect, and apply knowledge. According to the Revised Bloom's Taxonomy, "understanding" sits at the

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second level of the cognitive domain, requiring students to interpret, classify, and draw conclusions about concepts (Nafiati, 2021). Consequently, this ability serves as a crucial foundation for students to develop critical thinking, creativity, and problem-solving skills. Ideally, science instruction at the elementary level should be active, meaningful, and student-centered incorporating reading, discussion, and hands on activities so that students do not merely rote-memorize the material.

However, this ideal state has not yet been realized in practice. Data from the 2022 Programme for International Student Assessment (PISA) indicate that the scientific literacy of Indonesian students remains below the OECD average; only 34% of students achieved the minimum level of proficiency in understanding scientific concepts, compared to the OECD average of 76% (Dewi et al., 2025). This aligns with preliminary observations in elementary schools, which reveal that students tend to rote-memorize material, struggle to explain the content of readings in their own words, and lack the ability to connect concepts to real-life situations issues stemming from instruction dominated by the lecture method. These conditions highlight a significant gap between the ideal of active, student-centered science learning and the reality of instruction that remains teacher-centered.

Several key factors influence students' low level of conceptual understanding. Anisa et al. (2021) suggest that this lack of understanding stems from poor reading comprehension and critical thinking skills, as well as teacher-centered instructional patterns. Susanti and Ruqoyyah (2021) emphasize that the dominance of the lecture method results in students being less active in independently discovering knowledge and unable to summarize the material. Furthermore, Apriani et al. (2022) add that instruction focused on rote memorization leads students to read without grasping the text's content, thereby hindering their ability to draw scientific conclusions.

As a solution, the RADEC (Read, Answer, Discuss, Explain, and Create) learning model is implemented to accustom students to reading material independently, answering questions, engaging in discussions, explaining their reasoning, and producing meaningful work. The effectiveness of the RADEC model has been demonstrated by Ulfa et al. (2024), who successfully raised student literacy mastery from 18.52% to 81.48%, and by Andini and Fitria (2021), who confirmed its positive impact on learning outcomes and student engagement. Furthermore, Jatnika et al. (2024) found that RADEC is effective in enhancing elementary students' conceptual understanding of the human respiratory system.

However, a research gap exists because no prior studies have specifically examined the impact of the RADEC model on fifth-grade elementary students' conceptual understanding of biodiversity within the Natural and Social Sciences (IPAS) curriculum. This is significant given that the topic of biodiversity possesses unique characteristics requiring students to identify, classify, and relate forms of biodiversity to their environments. Therefore, this study aims to demonstrate the effect of the RADEC learning model on fifth-grade students' conceptual understanding of biodiversity, offering a more innovative and student-centered alternative to instruction.

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## 2. LITERATURE REVIEW

### 2.1. Understanding Science Concepts

Conceptual understanding is a crucial dimension within the cognitive domain that underpins the success of science learning in elementary schools. According to Anderson & Krathwohl (2001), understanding is defined as a learner's ability to construct meaning from information acquired through learning activities. This capacity for understanding is demonstrated through seven primary cognitive processes: interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining. Through this framework, understanding moves beyond rote memorization or the mere recognition of facts; instead, it focuses on the student's ability to process, connect, and organize scientific information in a deep and meaningful way.

The importance of this meaning-processing aspect is reinforced by Frans et al. (2023), who state that understanding is an individual's ability to truly grasp the content of learned material, enabling them to re-explain that information in their own words. This indicates that the process of understanding science concepts does not stop at the stage of passively receiving or recording information. Students are required to possess a profound ability to communicate the essence of the knowledge they have acquired and to connect fundamental science concepts in order to solve scientific problems encountered in daily life.

In this study, conceptual understanding is defined as the ability of elementary school students to deeply digest and master science material, assessed through indicators adapted from Krathwohl's (2002) theory. The indicators focus on six cognitive aspects tailored to the characteristics of the research subjects: interpreting, exemplifying, classifying, inferring, comparing, and explaining. Through these six indicators, the quality of students' science conceptual understanding can be measured in detail to determine the extent to which they are able to construct knowledge that is both holistic and functional.

### 2.2. Science Lesson on Biodiversity

Natural Science (IPA) instruction regarding biodiversity plays a fundamental role in linking students' conceptual understanding of scientific knowledge with the actual state of Indonesia's natural diversity. This curriculum is specifically designed to challenge students to go beyond merely memorizing species names; instead, they are expected to identify and classify various forms of flora and fauna based on regional zones—namely the Asiatic, Transitional, and Australis types. By understanding these geological and geographical zonations, students are guided to develop a critical awareness of the importance of environmental conservation from an early age. This aligns with the views of Widyanti et al. (2025), who state that science education should integrate scientific concepts with everyday realities, ensuring that classroom material is grasped in a manner that is contextual, meaningful, and applicable for learners.

Beyond strengthening a contextual mindset, mastering material on biodiversity specifically regarding regional characteristics positively influences the development of students' attitudes and character. A deep understanding of the distribution of flora and fauna unique to various Indonesian regions fosters national pride in the nation's immense

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biodiversity. This perspective is supported by Nusnida and Hidayat (2025), who explain that introducing and understanding local and national biological wealth directly cultivates a sense of care, responsibility, and a proactive attitude among students toward preserving their surrounding ecosystems. Thus, integrating conceptual knowledge of flora and fauna zonation with values of environmental stewardship transforms science education into an effective vehicle for shaping a young generation that is both academically intelligent and ecologically conscious.

### 2.3. The RADEC Learning Model

The RADEC (*Read, Answer, Discuss, Explain, and Create*) learning model is an innovative instructional syntax specifically designed to encourage students to learn actively, independently, and collaboratively through five systematic operational stages. This instructional syntax facilitates a harmonious integration of independent reading habits, the processing and testing of initial ideas, social interaction within group discussions, and the application of acquired knowledge into concrete products. Through this structured and directed learning flow, students are no longer positioned as passive recipients of information, but rather as active subjects who construct their own knowledge from the very beginning of the learning activities.

The fundamental concept of the RADEC learning model is formulated as a 21st-century learning strategy focused on comprehensively developing student potential. As stated by Sopandi (2017), the RADEC model serves as an innovative approach designed to stimulate learning independence, foster a positive climate of collaboration among students, and sharpen learners' productivity and creative thinking to meet the demands of the modern era. Each stage in RADEC provides space for students to practice critical thinking skills through structured tasks that challenge their curiosity.

The effectiveness of the RADEC learning flow in strengthening students' mastery of material is also supported by various academic findings. In line with this, Fuziani et al. (2021) explained that implementing the RADEC stages (*Read, Answer, Discuss, Explain, Create*) in a sequential and consistent manner is proven effective in helping students construct a deep and comprehensive understanding of the subject matter. By initiating the learning process with reading activities (*Read*) and answering questions (*Answer*), which are then consolidated through brainstorming (*Discuss*), concept clarification (*Explain*), and finalized with product creation (*Create*), students can fully internalize concepts, thereby producing stronger and more meaningful learning retention.

### 2.4. The Influence of the RADEC Model on Science Concept Understanding

The implementation of the RADEC (*Read, Answer, Discuss, Explain, and Create*) learning model syntax is consistently proven to have a highly significant positive impact on elementary school students' mastery of science material. Through a series of learning stages designed to be interactive and student-centered, this model is able to eliminate verbalistic learning patterns and the habit of rote learning without comprehension, which have long been the primary weaknesses of conventional approaches. Furthermore, this structured learning flow provides ample opportunities for students to explore ideas independently, thereby minimizing the occurrence of misconceptions from the very beginning of the science knowledge construction process.

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The success of this instructional flow is reinforced by various empirical evidence in elementary education literature. Jatnika et al. (2024) demonstrated in their study that the systemic and consistent implementation of the RADEC stages effectively enhances elementary students' understanding of science concepts. By requiring students to read (*Read*) and answer initial questions (*Answer*) prior to face-to-face classroom activities, students enter the learning process equipped with foundational knowledge ready to be consolidated, allowing the mastery of science concepts in class to proceed more effectively and deeply.

These positive impacts are also supported by empirical findings from Nurmitasari et al. (2023), who stated that the RADEC learning flow has a significant influence on improving science concept understanding by engaging students' emotional and cognitive domains in a balanced manner. Discussion (*Discuss*), explanation (*Explain*), and creation (*Create*) activities not only sharpen students' analytical thinking and cognitive abilities, but also foster motivation, self-confidence, and a positive social climate for learning. It is this balance between cognitive and emotional involvement that makes the internalization of science material more holistic, long-lasting in retention, and meaningful for learners.

## 3. METHODS

### 3.1. Research Type and Approach

This study employs a quantitative approach using a quasi-experimental design with a Non-equivalent Control Group Design. This approach was deliberately chosen to compare an experimental group and a control group without assigning subjects randomly (*random assignment*). This methodological decision was based on field conditions in elementary schools, which did not permit the researcher to reorganize existing naturally formed class compositions; thus, the instructional intervention had to be adapted to the existing classroom structure without disrupting school management.

The choice of a quasi-experimental design is grounded in the framework proposed by Sihotang (2023), who posits that a quasi-experimental approach is most appropriate when it is impossible for researchers to fully control all external variables that might influence the implementation of learning in real classrooms. In a dynamic school setting, environmental variables such as students' social backgrounds, home study habits, and daily interaction dynamics are difficult to isolate completely. Therefore, the use of this design provides a realistic yet scientifically measurable framework to test the effectiveness of instructional treatments in authentic classroom environments.

In its operation, the design procedure refers to Anantasia (2025), who states that a Non-equivalent Control Group Design measures differences in treatment impact by administering a initial test (*pretest*) prior to the intervention and a final test (*posttest*) after the intervention concludes for both subject groups being compared. The administration of the *pretest* aims to map the equivalence of students' initial cognitive abilities between the experimental and control groups. Subsequently, the treatment in the form of the RADEC learning model was applied to the experimental group while the control group received conventional instruction, which was then concluded with a *posttest* to measure the significance of the treatment's effectiveness.

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### 3.2. Population and Sample

The population of this study includes all fifth-grade elementary school students enrolled in the even semester of the 2025/2026 academic year in the Bendungan District, Trenggalek Regency. The determination of this population was based on the characteristics and needs of science/IPAS instruction at the local elementary school level, which required evaluation and instructional model innovation to optimize students' conceptual understanding. Framing the population within a single district aimed to establish a clear, measurable scope for the research that remained directly relevant to the instructional phenomena under investigation in the field.

The sampling technique in this study applied a purposive sampling approach based on specific objective criteria and considerations. The sample selection prioritized the equivalence of characteristics across schools, such as the homogeneity of students' academic abilities, the implementation of comparable curricula, and the presence of similar instructional challenges related to sub-optimal science concept understanding resulting from the dominance of conventional teaching. This methodological foundation refers to Sihotang (2023), who states that the population represents the entire research subject while the sample comprises a representative portion of it. This aligns with Zayrin (2025), who asserts that purposive sampling is a sample selection technique involving specific considerations or criteria to ensure that the chosen sample aligns precisely with the research objectives.

Based on these purposive sampling criteria, the sample established for this study comprised fifth-grade students from elementary schools in the Bendungan District, totaling 53 students. The inclusion of these 53 students was deemed to meet the representation requirements for reflecting the profile and characteristics of the fifth-grade student population at the research location. The sample subjects were subsequently divided into an experimental group, which received an intervention utilizing the RADEC learning model, and a control group, which implemented conventional instruction, allowing the impact of the treatment on students' conceptual understanding to be measured in a valid and comparative manner.

### 3.3. Research Instrument

The primary instrument used to measure the understanding of IPAS (Natural and Social Sciences) concepts was an objective multiple-choice test administered during the pretest and posttest. The test items were developed based on indicators of conceptual understanding and underwent validity and reliability testing prior to use in data collection. In this regard, Afif, et al. (2023) states that a sound test instrument must meet validity and reliability criteria to consistently measure learning outcomes, that dichotomously scored multiple-choice tests are highly efficient for objectively measuring students' mastery of concepts.

### 3.4. Research Procedure

The research procedure is divided into three main stages: the preparation stage, the treatment implementation stage, and the final evaluation stage. During the implementation stage, the experimental group received instruction on biodiversity using

the RADEC model, while the control group followed a conventional teaching model. These stages are based regarding the importance of administering a pre-test to assess baseline conditions and a post-test to measure the impact of the treatment, as well as Sopandi (2017) regarding the application of the RADEC model's procedural flow, which comprises the stages of Read, Answer, Discuss, Explain, and Create.

### 3.5. Data Analysis Techniques

The data regarding IPAS (Natural and Social Sciences) concept understanding, obtained from test results, were analyzed using descriptive and inferential statistical techniques. Prior to hypothesis testing via the Independent Sample t-test, the data underwent prerequisite testing involving Normality and Homogeneity of Variance tests. This procedure is based on Usmadi (2020) view that normality and homogeneity tests are absolute prerequisites for parametric statistical analysis, and is supported by Sihotang (2023), who states that the Independent Sample t-test is appropriate for testing the significance of the difference in mean scores between the experimental and control groups.

### 3.6. AI Tools

ChatGPT (OpenAI) and Gemini AI were used solely to assist in refining academic language and improving manuscript structure. These AI tools were not used for research design, data collection, data analysis, interpretation of results, or the formulation of scientific conclusions. All scientific content, research findings, and the final version of the manuscript were independently reviewed, verified, and approved by the authors, who bear full responsibility for the accuracy and integrity of the published work.

## 4. RESULTS AND DISCUSSION

This quantitative study employed a quasi-experimental design specifically a non-equivalent control group design involving 53 fifth-grade elementary school students in Bendungan District, Trenggalek Regency, during the even semester of the 2025/2026 academic year; the entire population was included in the sample via total sampling. The participating schools shared homogeneous characteristics and implemented an equivalent curriculum, yet faced challenges regarding students' limited understanding of science concepts due to a teacher-centered instructional approach. The study, which began with observations in February 2026 and was conducted from April to May 2026, divided the subjects into an experimental group using the RADEC learning model for the topic of biodiversity and a control group using a conventional approach to evaluate the model's effectiveness on students' conceptual mastery.

### 4.1 Description of Average Science Concept Understanding Scores

This study demonstrates a more optimal improvement in the understanding of science concepts regarding biodiversity in the experimental group which implemented the RADEC (Read, Answer, Discuss, Explain, and Create) learning model compared to the control group, which utilized conventional instruction. Prior to the intervention, both

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groups started with relatively balanced initial proficiency levels; the average pretest score was 52.40 for the experimental group and 51.80 for the control group. Following the intervention, the improvement in concept understanding was markedly higher in the experimental group than in the control group. The experimental group achieved an average posttest score of 84.60 (reflecting an average gain of 32.20 points), whereas the control group recorded an average posttest score of 68.20 (an average gain of 16.40 points).

This significant difference in final achievement and the magnitude of improvement demonstrates that the RADEC learning sequence is more effective than the conventional model in helping students construct, comprehend, and retain conceptual knowledge in science. The results of the study are as follows:

**Table 1.** Science Understanding Scores

| Class | Average Pretest | Average Posttes | Average N-gain |
|---|---|---|---|
| **Experimental (RADEC Model)** | 52.40 | 84.60 | 32.20 |
| **Control (Conventional)** | 51.80 | 68.20 | 16.40 |

## 4.2. Data Analysis Prerequisite Tests

Before hypothesis testing was conducted, the pretest and posttest data from both sample groups underwent prerequisite testing. This testing aimed to ensure that the obtained data met the fundamental assumptions of parametric statistics: normality and homogeneity of variance.

The Normality Test was performed to determine whether the pretest and posttest data for both the experimental and control groups followed a normal distribution. This analysis utilized the Shapiro-Wilk statistical test (with a significance level of $\alpha = 0.05$). The calculations revealed that the significance values for the pretest and posttest data in both the experimental and control groups were all greater than 0.05. Consequently, it can be concluded that the data distributions regarding science concept understanding in both sample groups were normal. Subsequently, a Homogeneity of Variance Test was conducted to determine whether the variances of the data from the experimental group (RADEC model) and the control group (conventional model) were equal. The results of the homogeneity test showed a significance value greater than 0.05 ($p > 0.05$). This indicates that the variances of the science concept understanding data for the experimental and control groups were homogeneous. Meeting these two prerequisites provided a valid methodological basis for proceeding with inferential analysis using parametric statistics.

## 4.3. Hypothesis Testing (t-test)

Hypothesis testing was conducted to determine the effectiveness and significance of the RADEC learning model's impact on fifth-grade elementary students' understanding of IPA concepts regarding biodiversity. The hypothesis was evaluated by comparing the post-test scores of the two groups using an Independent Sample t-test. The parametric statistical analysis yielded a calculated t-value greater than the t-table value, with a (2-tailed) significance level of 0.001 ($p < 0.05$). The statistical decision criteria state that if the (2-tailed) significance value is less than 0.05, the Null Hypothesis ($H_0$) is rejected and

the Working Hypothesis (Ha) is accepted. The rejection of $H_0$ and acceptance of Ha empirically and significantly demonstrate that the implementation of the RADEC (Read, Answer, Discuss, Explain, and Create) learning model has a tangible positive effect on improving fifth-grade students' understanding of biodiversity concepts in IPAS, compared to the use of conventional learning models.

## 5. CONCLUSION

Based on the research findings, it can be concluded that the RADEC (Read, Answer, Discuss, Explain, and Create) learning model has a significant effect on the understanding of science concepts regarding biodiversity among fifth-grade elementary school students. The results indicate that the average score of the experimental class rose from 58.69 in the pretest to 84.91 in the posttest, while the control class increased from 53.83 to 71.66. Normality tests showed that the data were normally distributed, and homogeneity tests confirmed that the data from both classes were homogeneous, thereby meeting the requirements for hypothesis testing. Furthermore, the Independent Sample t-test on the pretest data yielded a significance value of 0.059 (> 0.05), indicating that the students' initial proficiency levels in both the experimental and control classes were equivalent. Meanwhile, the Independent Sample t-test on the posttest data resulted in a significance value of 0.000 (< 0.05), demonstrating a significant difference between the two classes following the intervention.

This improvement in conceptual understanding occurred because each stage of the RADEC model Read, Answer, Discuss, Explain, and Create, helped students develop the indicators associated with conceptual understanding. Consequently, the RADEC learning model proved effective in enhancing students' understanding of biodiversity concepts compared to instruction that did not utilize the RADEC model.

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