



The Effect of the Read, Answer, Discuss, Explain, and Create (RADEC) Learning Model Assisted by SIPEMA on the Critical Thinking Skills of Fifth Grade Elementary School Students in the Respiratory System

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Received: December 26, 2025

Revised: February 27, 2026

Accepted: March 25, 2026

Published: March 31, 2026

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DOI: [10.29303/jppipa.v12i3.14101](https://doi.org/10.29303/jppipa.v12i3.14101)

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Abstract: This study aims to examine the effectiveness of the RADEC learning model assisted by SIPEMA, an Augmented Reality-based medium, in improving elementary school students' critical thinking skills on the human respiratory system topic. A quasi-experimental design with a nonequivalent control group was employed, involving an experimental class using the RADEC model and a control class using the Discovery Learning model. Both groups were supported by SIPEMA to control the influence of learning media. Critical thinking skills were measured using pretest and posttest instruments. Data were analyzed using descriptive and non-parametric inferential statistics. The Shapiro-Wilk test indicated non-normal data distribution. Therefore, non-parametric tests (Wilcoxon and Mann-Whitney U) were applied. The results showed a significant improvement in both groups ($p < 0.05$). The median scores increased more substantially in the experimental class compared to the control class. The N-Gain score in the experimental class (0.66) was higher than in the control class (0.42). Furthermore, the Mann-Whitney U test revealed a significant difference between the two groups ($p = 0.01$). These findings indicate that the RADEC model assisted by SIPEMA is more effective than Discovery Learning in improving students' critical thinking skills.

Keywords: Augmented Reality; Critical Thinking; RADEC; Respiratory System; SIPEMA.

Introduction

The world is currently in the era of the Industrial Revolution 4.0, which is characterized by rapid developments in technology and information across various aspects of life, including education. In this situation, individuals are required to possess various skills, one of which is critical thinking skills, which are essential for learning in the Industrial Revolution 4.0 era (Rafzan et al., 2020). The World Economic Forum even places critical thinking skills among the top ten essential skills required in the 21st century (Bangun & Pragholapati, 2021). Critical thinking is

widely recognized as an essential competence in 21st-century learning, involving the ability to analyze information, evaluate arguments, and make reasoned decisions.

Field conditions indicate that many students still experience difficulties in analyzing information, evaluating arguments, and connecting concepts with real-life situations. The Programme for International Student Assessment (PISA) report shows that Indonesian students' critical thinking abilities, especially in science, are still far behind those of other countries (OECD, 2023). Learning practices that emphasize memorization rather than conceptual understanding are one of the main causes of low critical thinking skills. In

How to Cite:

Alfazuri, N., & Tyas, D. N. (2026). The Effect of the Read, Answer, Discuss, Explain, and Create (RADEC) Learning Model Assisted by SIPEMA on the Critical Thinking Skills of Fifth Grade Elementary School Students in the Respiratory System. *Jurnal Penelitian Pendidikan IPA*, 12(3), 513-523. <https://doi.org/10.29303/jppipa.v12i3.14101>

classroom learning, students tend to be passive recipients of information rather than active problem solvers. This condition indicates that the existing learning system has not fully prepared students to face real world challenges. Previous studies indicate that students' critical thinking skills can be improved through innovative learning models and technology-based media that encourage active learning and conceptual understanding (Andariana et al., 2025; Kurnia et al., 2025; Puspitaningrum et al., 2025; Rooshadiya et al., 2025; Simorangkir et al., 2025). This problem demands innovation in learning models that can train students' critical thinking skills. The learning model applied should encourage students to deeply understand concepts rather than merely memorize them. One subject that requires such innovation is science (IPA), particularly the human respiratory system material, which is often understood superficially and memorized without deep comprehension.

In this material, students are required not only to memorize theory but also to explore and analyze concepts by involving critical thinking skills so that the knowledge can be applied in daily life. Unfortunately, learning about the respiratory system in elementary schools is still monotonous and less challenging. Students only memorize respiratory organs without truly understanding how the system works in the human body. As a result, students' understanding is shallow and their critical thinking skills are not effectively developed.

One alternative solution to this problem is the implementation of the Read, Answer, Discuss, Explain, and Create (RADEC) learning model. This learning model emphasizes five main stages oriented toward independent thinking and concept exploration, namely reading material before learning (Read), answering pre-learning questions (Answer), discussing concepts in groups (Discuss), explaining discussion results (Explain), and creating or applying concepts in relevant real projects (Create) (Yohana et al., 2022). The RADEC model has been proven to improve students' conceptual understanding and develop more systematic and critical thinking patterns (Fuadi et al., 2021; Suryana et al., 2021). However, despite its structured stages, the RADEC learning model still faces challenges in engaging all students actively, particularly when the learning material is abstract and difficult to visualize. This indicates that a structured pedagogical approach alone is not sufficient and needs to be supported by appropriate learning media (Rahma et al., 2024).

One supportive learning medium that can assist the implementation of the RADEC learning model is SIPEMA. SIPEMA stands for *Sistem Pernapasan Manusia* (Human Respiratory System). SIPEMA is an Augmented

Reality (AR)-based application supported by flashcards, designed to help students visualize the human respiratory system more clearly and interactively (Ma'rufah, 2025). AR presents learning material through immersive visual displays that help students better understand abstract concepts (Demircioglu et al., 2023; Ismail et al., 2025; Misliza et al., 2025; Nursyaidah et al., 2025). Augmented Reality (AR) is considered a suitable complement to the RADEC model because it enables students to visualize abstract and complex processes, such as the human respiratory system, in an interactive and immersive way. Through AR, students can observe three-dimensional representations of organs and processes that are difficult to imagine through text-based learning, thereby supporting deeper conceptual understanding that facilitates the learning process (Hincapie et al., 2021; Mansour et al., 2025; Ratih et al., 2025; Syawaludin et al., 2019).

Several previous studies have examined the effectiveness of the RADEC model and AR-based media separately in elementary science learning. However, these studies have not fully explored the integration of a structured learning model with supportive visualization technology within a single instructional framework. In addition, previous studies have not specifically examined how AR-based media can function as a supportive tool within a learning model to enhance students' critical thinking skills. For example, Suryana et al. (2021) and Fiteriani et al. (2025) found that the RADEC model improves students' creative thinking skills through the stages of Read, Answer, Discuss, Explain, and Create in science learning. Meanwhile, Ma'rufah (2025) revealed that the use of SIPEMA in learning increases student engagement and critical thinking skills. However, previous studies still have limitations. The RADEC model has not been implemented together with technology-based learning media such as SIPEMA integrated with Augmented Reality. In addition, previous SIPEMA studies have not been tested within a specific learning model framework. Therefore, no studies have integrated both the model and the media simultaneously, particularly on respiratory system material for fifth-grade elementary students.

Based on this research gap, this study offers a specific novelty by integrating a supportive Augmented Reality-based medium (SIPEMA) into the structured stages of the RADEC learning model. Unlike previous studies that examined learning models and media separately, this study positions SIPEMA as a supportive tool to facilitate visualization, while the RADEC model remains the primary instructional approach in developing students' critical thinking skills. This research is important because elementary students often experience difficulties in understanding abstract

biological processes, such as the human respiratory system, when learning is limited to memorization and verbal explanations. Without appropriate instructional support, students tend to develop superficial understanding and low critical thinking skills. Therefore, combining structured learning models with supportive visualization tools is necessary to create more meaningful and effective learning experiences.

This integration is expected to optimize the development of critical thinking skills through a systematic, interactive, and technology-based learning flow. Accordingly, this study aims to examine the implementation of the RADEC learning model assisted by SIPEMA on the human respiratory system material, to analyze students' critical thinking skills after the implementation of the model, and to compare the effectiveness of the RADEC learning model assisted by SIPEMA and the Discovery Learning model assisted by SIPEMA in improving students' critical thinking skills. In this study, SIPEMA is used equally in both groups as a supportive medium, while the primary difference lies in the learning model applied.

The results of this study are expected to contribute to improving students' critical thinking skills. In addition, this research can serve as a reference for teachers in implementing innovative learning to create more engaging and meaningful learning experiences for students.

Method

Research Design and Method

This study employed a quantitative approach using a quasi-experimental design. The research design applied was the Nonequivalent Control Group Design, which involved two groups, namely an experimental group that implemented the RADEC learning model and a control group that received instruction using the Discovery Learning model. Both groups utilized SIPEMA as a supporting learning medium to ensure equal media exposure. Therefore, SIPEMA functioned as a control variable, while the primary variable examined in this study was the learning model. However, the primary distinction of treatment lies in the instructional model applied, namely RADEC in the experimental class and Discovery Learning in the control class. This design was selected to enable comparison of students' critical thinking skills under two different instructional models while maintaining natural classroom conditions without random assignment. The research design used in this study is presented in figure 1.

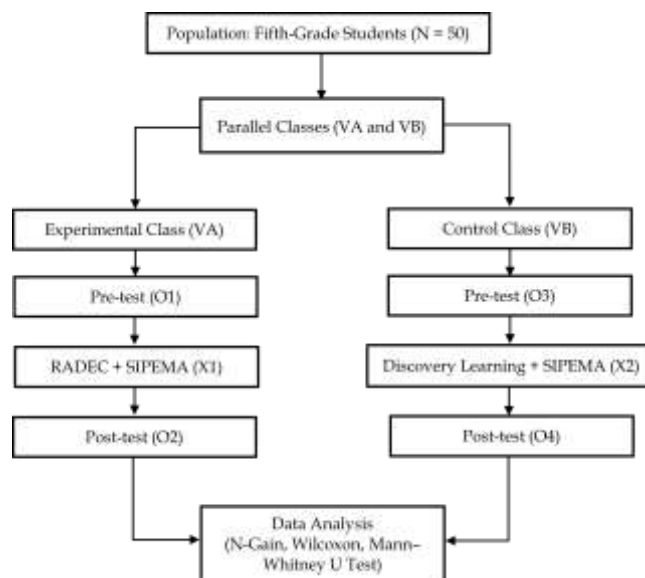


Figure 1. Nonequivalent Control Group Design of the Study

The research procedure followed a sequence of pretest, treatment, and posttest in both groups, with different instructional models applied in each class. Based on the research design described above, the variables in this study are defined as follows.

- 1) Independent variable: learning model (RADEC and Discovery Learning)
- 2) Dependent variable: Students' critical thinking skills
- 3) Control variable: SIPEMA learning media

Research Subjects and Location

This study was conducted at SDN Wates 01 during the even semester of the 2025/2026 academic year. The research population consisted of all fifth-grade students at SDN Wates 01, totaling 50 students. The sampling technique used was total sampling because the population size was relatively small (50 students) (Sugiyono, 2019). The sample consisted of two parallel classes (VA and VB) which had similar academic characteristics. These existing classes were assigned as experimental and control groups without randomization, in accordance with the quasi-experimental design.

Research Hypothesis

This study compared students' critical thinking skills between the experimental class and the control class on the human respiratory system material. The experimental class received instruction using the RADEC learning model assisted by SIPEMA media, while the control class received instruction using the Discovery Learning model assisted by SIPEMA. The conceptual framework and the relationship between the variables studied are illustrated in Figure 2.

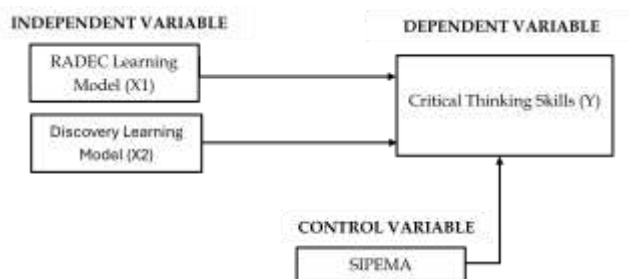


Figure 2. Research Variable Relationship Diagram

This figure illustrates the relationship between the variables in this study. The learning model (RADEC and Discovery Learning) acts as the independent variable that influences students’ critical thinking skills as the dependent variable. SIPEMA is treated as a control variable to ensure that external factors remain consistent during the learning process. Based on the relationship between variables described above, the hypotheses of this study are formulated as follows.

- 1) H_0 (Null Hypothesis): There is no significant difference in the critical thinking skills of fifth-grade students between those taught using the RADEC learning model assisted by SIPEMA and those taught using the Discovery Learning model assisted by SIPEMA.
- 2) H_a (Alternative Hypothesis): There is a significant difference in the critical thinking skills of fifth-grade students between those taught using the RADEC learning model assisted by SIPEMA and those taught using the Discovery Learning model assisted by SIPEMA.

Data Collection and Analysis Techniques

Research data were obtained through critical thinking skills tests administered in the form of pretests and posttests to both groups. The test instruments were developed based on Facione’s critical thinking indicators (Noris et al., 2024). The indicators used in developing the instrument included analysis, interpretation, and inference. This instrument was used to obtain quantitative data on students’ critical thinking skills after the treatment.

Data analysis was conducted using descriptive and inferential statistics. Descriptive analysis was used to describe the pretest and posttest results of both groups. The next stage involved the Shapiro–Wilk normality test to determine the appropriate type of inferential analysis. The selection of inferential statistical tests was based on the results of the normality test. When the data were not normally distributed, non-parametric tests such as the Wilcoxon test and Mann–Whitney U test were applied. To determine changes in abilities within each group, the Wilcoxon test was used. N-Gain calculations were conducted to assess the effectiveness of improvements

in critical thinking skills after treatment. Subsequently, the Mann–Whitney U test was applied to compare posttest results between the experimental and control groups to determine whether there was a significant difference after treatment implementation.

Instrument Validity

The pretest and posttest instruments used in this study underwent a series of feasibility tests to ensure measurement quality. Content validity was obtained through expert judgment involving a lecturer specializing in science subject matter. Furthermore, empirical validity testing was conducted by correlating item scores with total scores using Microsoft Excel.

In addition, the researcher examined item difficulty levels and discrimination indices to assess the quality of each test item. The instrument initially consisted of 50 items, which were tested for empirical validity. Based on the validity analysis, only 24 items met the required criteria and were therefore selected as the final instrument. Only valid and reliable items were used in the pretest and posttest. Instrument internal consistency was measured using Cronbach’s Alpha, which yielded a value of 0.88. This value indicates that the instrument was highly reliable and suitable for this study.

Result and Discussion

Implementation of the RADEC Model Assisted by SIPEMA

The implementation of the RADEC learning model assisted by SIPEMA media on the human respiratory system material in fifth-grade students at SDN Wates 01 was conducted over four meetings. Each meeting followed five main stages: Read, Answer, Discuss, Explain, and Create (Handayani et al., 2019; Hana Lestari et al., 2023). During the Read stage, students were instructed to independently read introductory material on the human respiratory system through textbooks, learning videos, and instructional materials available in the SIPEMA application. In addition, students observed visual representations of respiratory organs through flashcards that could be scanned using the application, allowing each respiratory organ to be viewed in 3D form. At this stage, the teacher instructed students to pay attention to the shape, position, function of organs, and airflow sequence. Students were then asked to record important findings obtained from SIPEMA media and instructional materials, such as “the right lung is larger than the left lung.” The Read stage aimed to build prior knowledge and provide initial conceptual understanding before students entered higher-level analytical stages.

The Read stage was followed by the Answer stage, in which students responded to guiding questions designed to stimulate critical thinking, such as “What

happens when we block our nose?" Next were the Discuss and Explain stages, which provided students with opportunities to discuss, exchange opinions, and verbally explain their findings to peers and teachers, enabling them to develop more logical and structured arguments.



Figure 3. Students Discussing During the RADEC Learning Process

In the Create stage, students constructed a simple model of the human respiratory system using a plastic bottle and balloons to simulate lung function. The balloon placed inside the bottle represented the lungs, while the movement of air was demonstrated through the expansion and contraction of the balloon. This activity allowed students to visualize the processes of inspiration and expiration more concretely. Using SIPEMA as a reference, students interpreted their observations and explained the relationship between respiratory organ function and airflow in a more structured manner.



Figure 4. Student activities during the Create stage in the experimental class

The effectiveness of implementing the RADEC model assisted by SIPEMA was evident from students' critical thinking test results at the final meeting. Scores in the experimental class tended to be higher and more stable, with score ranges of 75-95, indicating that the overall RADEC stages helped students understand concepts sequentially and deeply. Interactive visualization through SIPEMA greatly supported the

Read, Answer, and Create stages, as students were able to observe respiratory anatomy structures that are typically difficult to comprehend through text or teacher explanations alone.

Thus, the implementation of the RADEC model assisted by SIPEMA showed positive learning outcomes. Students were actively involved in each stage and demonstrated improvement in critical thinking skills. However, these findings should be interpreted with consideration of initial differences between groups. (Tyas et al., 2021).

Analysis of the Improvement in Students' Critical Thinking Skills

The analysis of the improvement in students' critical thinking skills began by examining the pretest and posttest data from both the control and experimental classes. Descriptive statistics are presented to provide an overview of the data distribution. Although mean values are reported for general description, the interpretation of the data is supported by non-parametric statistical analysis due to the non-normal distribution of the data. Therefore, the interpretation of the results focuses on general patterns and comparisons between groups rather than on parametric assumptions. A summary of the descriptive statistical results is presented in Table 1.

Table 1. Descriptive Statistics of Pretest and Posttest Scores for Control and Experimental Classes

| Variable | N | Range | Min | Max | Mean | SD |
|--------------|----|-------|-----|-----|-------|-------|
| Pretest (c) | 25 | 55 | 20 | 75 | 50.40 | 18.37 |
| Posttest (c) | 25 | 55 | 35 | 90 | 72.60 | 18.86 |
| Pretest (e) | 25 | 65 | 15 | 80 | 36.60 | 14.22 |
| Posttest (e) | 25 | 25 | 70 | 95 | 80.20 | 7.29 |

The descriptive statistical analysis shows that students' initial abilities in the two classes were different. In the control class, pretest scores ranged from 20 to 75, indicating moderate initial ability with considerable variation among students. Meanwhile, the experimental class pretest scores ranged from 15 to 80, indicating that students' initial abilities in the experimental class were relatively lower than those in the control class.

The initial difference in pretest scores indicates that the experimental group started with a lower baseline compared to the control group. This condition may influence the magnitude of improvement, as students with lower initial scores tend to show higher gains. Therefore, this difference should be considered when interpreting the improvement results.

After the implementation of different learning treatments, the experimental class showed higher and more consistent posttest results compared to the control

class. The narrower score range and more stable distribution in the experimental class indicate that students' performance improved more evenly compared to the control class. These descriptive findings should be interpreted with caution, as the data were not normally distributed, and therefore further analysis was conducted using non-parametric statistical tests.

A normality test was conducted as a prerequisite step to determine the appropriate statistical test. This test aimed to identify whether students' critical thinking skill test data were normally distributed. The results of the normality test are presented in Table 2.

Table 2. Normality Test Results of Pretest and Posttest Data for Control and Experimental Classes

| Class | Test Phase | N | Shapiro-Wilk | Sig. |
|--------------|------------|----|--------------|------|
| Control | Pretest | 25 | 0.92 | 0.04 |
| Control | Posttest | 25 | 0.84 | 0.00 |
| Experimental | Pretest | 25 | 0.87 | 0.01 |
| Experimental | Posttest | 25 | 0.93 | 0.07 |

The Shapiro-Wilk test was used because the number of subjects in each group was fewer than 50 students. The decision criterion states that if the significance value (Sig.) > 0.05, the data are normally distributed, whereas if Sig. ≤ 0.05, the data are not normally distributed. The results show that the significance values for the control class pretest (0.04), control class posttest (0.00), and experimental class pretest (0.01) were ≤ 0.05, indicating non-normal distributions. Only the experimental class posttest data were normally distributed (Sig. = 0.07). Therefore, it can be concluded that the critical thinking skill test data were not normally distributed overall, and non-parametric statistical tests were applied.

Table 3. Wilcoxon Signed Rank Test for the Control Class

| Component | Value |
|-----------------|-------|
| N | 25 |
| Negative ranks | 0 |
| Positive ranks | 23 |
| Ties | 2 |
| Z | -4.21 |
| Sig. (2-tailed) | 0.00 |

Based on the results of the Wilcoxon Signed Rank Test above, it was found that out of 25 participants, 23 participants experienced an increase in scores (positive ranks), no participants had posttest scores lower than pretest scores (negative ranks = 0), and 2 participants had the same scores between pretest and posttest (ties). This indicates that improvement was not uniformly experienced by all students. This may be influenced by

differences in individual readiness, learning motivation, or adaptation to the learning model.

The test results showed a Z value of -4.21 with a significance value of 0.00 (< 0.05). This means that there was a significant difference between pretest and posttest scores in the control class. The learning provided in the control class still had an effect on improving students' critical thinking skills, even though it did not use the RADEC learning model.

The Wilcoxon Signed Rank Test was also applied to the experimental class to determine improvements in students' abilities after the learning treatment was implemented. The complete results are presented in Table 4.

Table 4. Wilcoxon Signed Rank Test Results for the Experimental Class

| Component | Value |
|-----------------|-------|
| N | 25 |
| Negative ranks | 0 |
| Positive ranks | 23 |
| Ties | 2 |
| Z | -4.21 |
| Sig. (2-tailed) | 0.00 |

Based on the results of the Wilcoxon Signed Rank Test in the experimental class, it was found that out of 25 students, 23 students experienced an increase in scores from pretest to posttest, while no students experienced a decrease in scores. In addition, there were 2 students who had the same scores before and after learning.

The analysis results showed a Z value of -4.21 with a significance value of 0.00 (p < 0.05). This significance value indicates that there was a significant difference between pretest and posttest scores in the experimental class after being given treatment using the RADEC learning model assisted by SIPEMA media. The absence of negative ranks indicates that most students experienced improvement, while the presence of ties indicates that there were still a small number of students who did not show score improvement despite participating in the learning. Overall, these results indicate that the implementation of the RADEC learning model assisted by SIPEMA had a significant positive impact on improving students' critical thinking skills. Therefore, it can be said that the treatment in the experimental class supported the achievement of student competencies.

After the Wilcoxon test showed differences in improvement in each class, descriptive analysis was needed to examine the pattern of score increases more clearly. To further analyze the magnitude of improvement, N-Gain analysis was conducted. Therefore, descriptive statistics of N-Gain scores in both groups are presented in Table 5. The N-Gain values were

converted into a 0-1 scale to align with the standard interpretation of normalized gain.

Table 5. Descriptive Statistics of N-Gain Scores

| Statistic | Control | Experimental |
|-----------|-------------|--------------|
| Mean | 0.42 | 0.66 |
| 95% CI | 0.31 - 0.52 | 0.57 - 0.75 |
| Median | 0.46 | 0.71 |
| SD | 0.26 | 0.22 |
| Variance | 0.65 | 0.48 |
| Min-max | 0.00 - 0.78 | 0.00 - 0.88 |
| Range | 0.78 | 0.88 |
| IQR | 0.47 | 0.17 |

The descriptive analysis results show that the improvement in student learning outcomes in the experimental class was higher and more consistent compared to the control class. This is reflected in the higher median N-Gain score of the experimental class (0.71) compared to the control class (0.46). The mean N-Gain score also supports this finding, with the experimental class reaching 0.66, which is higher than the control class at 0.42. The difference in N-Gain scores between the two groups indicates a stronger improvement in the experimental class. In addition, the experimental class showed more consistent improvement, as indicated by lower variability, which can be seen from the smaller standard deviation and interquartile range values in the experimental class compared to the control class. Meanwhile, the control class showed more varied improvement among students. Overall, these descriptive statistics indicate that RADEC learning assisted by SIPEMA provided a greater and more stable impact on improving student learning outcomes compared to learning using the Discovery Learning model assisted by SIPEMA.

Comparison of the Effectiveness of the RADEC Learning Model Assisted by SIPEMA and the Discovery Learning Model Assisted by SIPEMA

The comparison of learning outcomes between the experimental class and the control class was analyzed using the Mann-Whitney U test. This test was used to determine whether there was a significant difference in posttest results between the two groups. A summary of the analysis results is presented in Table 6.

Table 6. Mann-Whitney U Test Results

| Component | Value |
|-----------------|--------|
| Mann-whitney u | 173.50 |
| Wilcoxon w | 498.50 |
| Z | -2.73 |
| Sig. (2-tailed) | 0.01 |

Based on the analysis using the Mann-Whitney U test on posttest scores of the experimental class and the

control class, a Mann-Whitney U value of 173.50 was obtained, a Wilcoxon W value of 498.50, a Z value of -2.73, and a significance value of 0.01 ($p < 0.05$). The significance value that is smaller than 0.05 indicates that the null hypothesis (H_0) was rejected and the alternative hypothesis (H_a) was accepted. The results of students' critical thinking skills tests in the experimental class and the control class came from two different distributions, so it can be stated that the learning treatment had an effect on students' critical thinking skills.

The research results show a significant improvement in students' critical thinking skills in both the experimental and control classes after learning was implemented. However, the improvement that occurred in the experimental class using the RADEC learning model assisted by SIPEMA was superior compared to the control class using the Discovery Learning model assisted by SIPEMA. These findings indicate that the RADEC model has stronger effectiveness in improving critical thinking skills than the Discovery Learning model on respiratory system material. These findings are consistent with previous research indicating that the RADEC learning model can effectively promote students' critical thinking skills through its structured learning stages (Satria & Sopandi, 2019). These results are also in line with research conducted by Deviyanti et al. (2025), which showed that RADEC is more effective than Discovery Learning in improving students' critical thinking skills, thereby further strengthening that the RADEC learning model assisted by SIPEMA is able to provide more significant improvement.

Theoretically, these results can be explained through a constructivist approach. RADEC provides learning scaffolding that is in accordance with Vygotsky's Zone of Proximal Development concept, in which students are guided through systematic stages before achieving independent understanding (H. Lestari et al., 2021; Setiawan et al., 2020). Through these stages, students are not immediately required to discover concepts as in Discovery Learning, but are directed through gradual processes that allow knowledge internalization to occur. These findings are also strengthened by other research results which found that the progressive syntax structure of RADEC is effective in improving critical thinking skills and 21st-century skills because it supports gradual concept development (Burhanudin et al., 2024; Fitri et al., 2023; Nurul Delima Kiska et al., 2024; Sukardi et al., 2021).

The step-by-step approach in RADEC is also aligned with other cognitive development theories. Bruner explained that conceptual understanding is formed through three stages of representation, namely enactive, iconic, and symbolic (Mutaqin et al., 2021). The enactive stage appears when students carry out activities in the Read stage, because at this stage they read

materials, watch learning videos, and observe 3D models of respiratory organs through the SIPEMA application. These activities involve direct experience, such as observing the shape of the lungs or recording important information found.

The process continues to the iconic stage when students begin to answer questions, discuss, and represent concepts through tables or images. At this stage, students' understanding begins to form through visualization and exchange of ideas. The final stage is symbolic, which can be seen when students explain the results of their thinking orally and create products in the Create stage, such as simple models or respiratory maps. At this stage, students are already able to use appropriate terms and explain concepts in a more structured manner.

When further reviewed from the aspect of cognitive development, this model is in accordance with the characteristics of elementary school students. Based on Piaget's theory, most elementary school students are in the concrete operational stage, where students require structured, manipulative, and experience-based learning activities to be able to think logically (Efendi, 2022; Zakirman et al., 2022). Research by Huda & Susdarwono (2023) shows that students aged 7–11 years require concrete media and systematic learning flows to process information according to their cognitive development, so a model such as RADEC is very relevant to support their way of thinking.

In addition to learning theory, the learning media used also influenced student achievement. SIPEMA functioned as a supporting tool that helped students visualize abstract concepts, thereby facilitating the implementation of the learning model. Previous studies by Ma'rufah (2025) also showed that SIPEMA can improve science learning outcomes, particularly on human respiratory system material.

Discovery Learning used in learning in the control class also provided opportunities for students to explore and discover concepts independently. However, some students were not yet accustomed to inquiry-based learning, which requires a higher cognitive load. These findings are supported by Cairns (2025), who emphasized the importance of balancing student-centered and teacher-guided approaches in learning. Fully student-directed learning may not always be optimal for all learners, particularly when it imposes a high cognitive load. Therefore, structured learning models that provide scaffolding, such as RADEC, are more effective in supporting students' understanding.

Conclusion

This study concludes that the RADEC learning model assisted by SIPEMA media can be effectively

implemented in learning the human respiratory system in grade V, as reflected in the well-executed learning syntax and active student engagement. The findings indicate that both the experimental and control classes showed improvement in students' critical thinking skills. However, the RADEC learning model demonstrated greater effectiveness than the Discovery Learning model. Therefore, the RADEC learning model assisted by SIPEMA is more effective in enhancing students' critical thinking skills.

Acknowledgments

The author would like to express gratitude to the academic supervisor who provided guidance and feedback throughout the research process. Appreciation is also extended to the school principal, classroom teachers, and students of class VA and VB of SDN Wates 01 for granting permission and participating in the implementation of the research. In addition, the author would like to thank family members and all parties who provided support during the research process and the preparation of this article.

Author Contributions

Conceptualization, Nafisa Alfazuri and Dewi Nilam Tyas; methodology, Nafisa Alfazuri; software, Nafisa Alfazuri; validation, Dewi Nilam Tyas; formal analysis, Nafisa Alfazuri; investigation, Nafisa Alfazuri; resources, Nafisa Alfazuri; data curation, Nafisa Alfazuri and Dewi Nilam Tyas; writing—original draft preparation, Nafisa Alfazuri; writing—review and editing, Nafisa Alfazuri and Dewi Nilam Tyas; visualization, Nafisa Alfazuri; supervision, Dewi Nilam Tyas; project administration, Nafisa Alfazuri and Dewi Nilam Tyas; funding acquisition, Nafisa Alfazuri. All authors have read and agreed to the published version of the manuscript.

Funding

This research received no external funding

Conflicts of Interest

All authors declare no conflict of interest.

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