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RADEC Model on Critical Thinking Skills of Science Education In Elementary School: A Systematic Literature Review

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Abstract: This study employs a Systematic Literature Review (SLR) guided by the PRISMA 2020 protocol to evaluate the effectiveness of the RADEC (Read, Answer, Discuss, Explain, and Create) learning model in enhancing critical thinking skills among elementary school students. A total of 21 peer-reviewed studies published between 2019 and 2025 were analyzed. The findings show that the RADEC model enhances critical thinking, particularly in science education. Through its structured stages, the model promotes active engagement, social interaction, reflective thinking, and conceptual understanding. Despite these benefits, challenges such as low student literacy, limited teacher readiness, and insufficient institutional support were identified. These results highlight the need for comprehensive teacher training and institutional support to ensure successful implementation. The RADEC model presents itself as a promising and adaptable approach for promoting 21st-century competencies in primary education.

Keywords: Critical thinking; Elementary school; Radec model.

INTRODUCTION

Education plays a vital role in developing learners into independent, creative, and competitive individuals who contribute meaningfully to society. It nurtures spiritual, cognitive, social, and emotional capacities (Kartini & Kusmanto, 2022; Yulianto et al., 2023). In the 21st century, education must foster life skills, reflective thinking, and adaptability to address modern global challenges (UNESCO, 2017). Among the key competencies emphasized, critical thinking is essential as it enables learners to analyze, evaluate, and apply information effectively (Facione, 2011; Setiawan et al., 2022). However, Indonesian students' critical thinking abilities remain low. The 2022 PISA results ranked Indonesia 74th out of 81 countries in reading, mathematics, and science (OECD, 2023). This underperformance is partly due to conventional, teacher-centered instruction with minimal interaction (Anggraeni et al., 2018). Passive learning methods hinder the development of higher-order reasoning and communication skills (Darling-Hammond et al., 2020).

To overcome this issue, innovative and student-centered learning models are required. The RADEC learning model (Read, Answer, Discuss, Explain, and Create) is one such alternative, designed to foster cognitive engagement and social collaboration (Kusumaningpuri & Fauziati, 2021; Yulianti et al., 2022). Rooted in Vygotsky's social constructivism, RADEC emphasizes that knowledge is constructed through meaningful social interaction (Vygotsky, 1978). Research has shown that RADEC is effective in strengthening critical thinking, especially in science learning (Maftuh et al., 2024; Tulljanah & Amini, 2021; Zalukhu et al., 2024). However, barriers such as low literacy skills, teacher readiness, and institutional limitations are frequently reported (Rohmatillah et al., 2024; Satria & Sopandi, 2019). Therefore, this study aims to: (1) analyze the effectiveness of the RADEC model in enhancing elementary students' critical thinking skills; (2) describe the contexts in which the model is

implemented; (3) identify the key challenges encountered in its application; and (4) propose recommendations for more effective use of the model in primary education

Table 1. RADEC Model Learning Stages

Learning Stage	Teacher Role	Student Role
Read	Teachers monitor and encourage students to read learning materials independently before learning activities take place. Teachers also direct students to look for sources of information from various media, such as books, e-books, the internet, and other media.	Students are responsible for reading the material independently at home and finding as much information as possible on the topic to be discussed, as a provision for discussion activities in class.
Answer	The teacher develops pre-learning questions that are closely related to the material to be learned. These questions are designed to activate students' prior knowledge before they enter into the discussion.	Students answer the questions given by the teacher independently before the learning begins. These answers become the basis for group discussions in class.
Discuss	The teacher encourages students who have understood the material to help their group mates who are having difficulty. The teacher also ensures that the discussion is active and communicative, and motivates students who do not understand to ask their friends.	Students discuss in small groups to discuss the answers they have made before. In this discussion, students exchange ideas and help each other so that all group members understand the material thoroughly.
Explain	The teacher helps direct groups that have difficulties when explaining the material. He also ensures that the explanation from the group representatives can be received and understood by all students. In addition, the teacher provides additional material if there are parts that students have not mastered, and encourages other students to respond to the group presentations.	Each group appoints one representative to present the results of the discussion in front of the class. Other group members and other groups are encouraged to provide responses in the form of questions, rebuttals, or additional information to the explanation presented.
Create	The teacher motivates students to express their creative ideas in the form of real work. The teacher also guides the process of making the work and assists students in preparing a report on the results of their work.	Students discuss creative ideas in groups and realize them in the form of work or learning products. After that, students compile a report as a form of accountability for the work they have made.

Critical thinking is defined as the ability to analyze, evaluate, and conclude information logically and rationally. According to Ennis (2011), critical thinking includes skills such as identifying assumptions, evaluating arguments, and making decisions based on evidence. In

the context of basic education, critical thinking skills are essential to help students understand concepts, solve problems, and make responsible decisions (Fajari et al., 2020). Therefore, a learning approach that encourages students to actively think, question and reflect on information is needed. The stages in the RADEC model are systematically designed to foster students' critical thinking skills. For example, the Discuss and Explain stages encourage students to express opinions, listen to other people's ideas, and formulate logical arguments (Chellsy, Y. 2024). Meanwhile, the Create stage encourages the application of knowledge in the form of products that reflect students' understanding and creativity. Through this learning cycle, students not only gain knowledge, but also build critical thinking skills in a sustainable manner.

METHODS

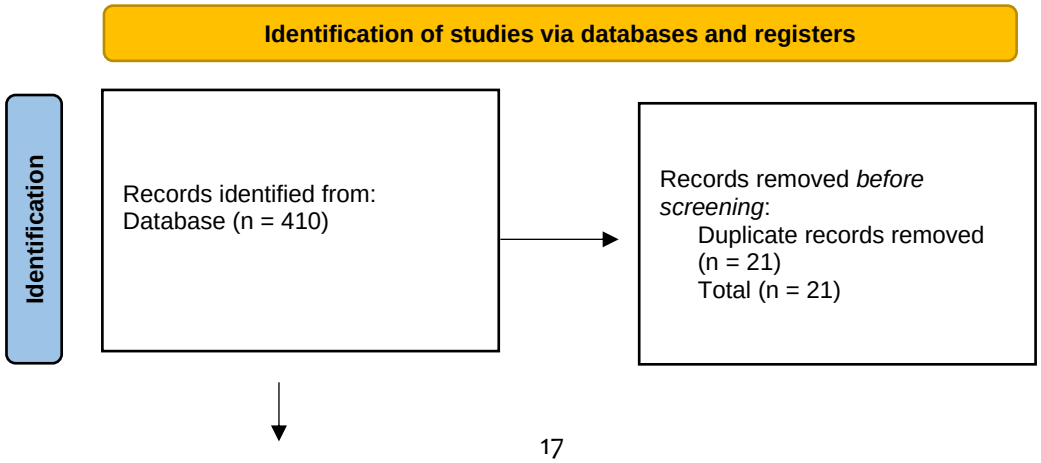
This study uses the Systematic Literature Review (SLR) method which refers to the PRISMA 2020 guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). (Page et al., 2021). This approach was chosen because it allows researchers to systematically collect, assess, and synthesize the results of previous research relevant to the topic, in this case the effectiveness of the RADEC learning model in improving the critical thinking skills of elementary school students in science subjects.

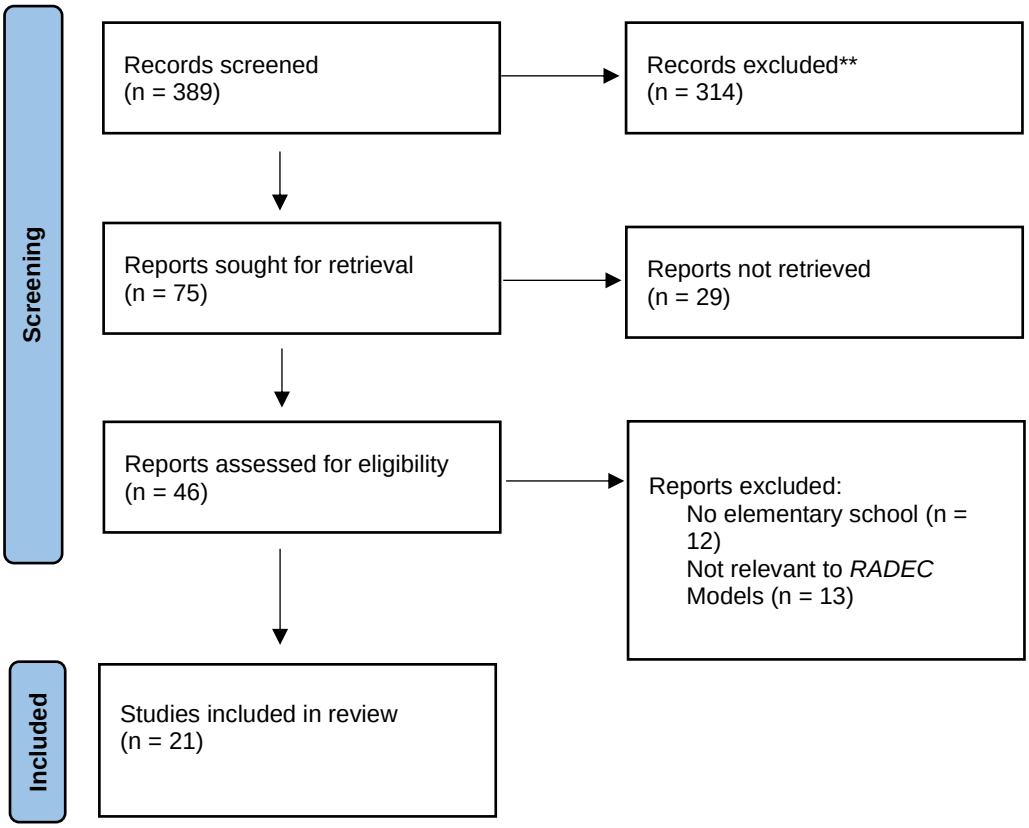
On April 22, 2025, researchers conducted a literature search using Google Scholar and Erics with online data sources. The selection of research is based on the following Table 1 criteria:

Table 2. Article Selection Criteria

Inclusion Criteria	Inclusion Criteria
Publication year 2019-2025	Publication before 2019
Jurnal peer review	Not jurnal peer review
Speak Indonesian or English	Not Bahasa Indonesia or English
Related to learning using RADEC model in improving students' critical thinking in elementary school	Not related to RADEC in improving students' critical thinking in elementary school

The search used the keywords “RADEC model”, “critical thinking” and “elementary school”. From the search results, 410 articles were obtained. Next, the articles were selected through title, abstract, and full text by referring to the criteria in Table 2. In the selection, researchers still use manual methods. Furthermore, the process of coding, extraction, and analysis was carried out by pouring the information needed by researchers into a Spreadsheet. In the end, out of 410 articles obtained, only 21 articles were included in the criteria. The following is the complete process related to article selection.





Picture 1. Flow of article selection
Adapted from (Page et al., 2021)

Data analysis in this study was conducted through several systematic stages. Data were collected from various online databases such as Google Scholar and ERIC using the keywords "RADEC model", "critical thinking", and "elementary school" within the publication range of 2019 to 2025. From the initial search results of 410 articles, a selection was made based on the PRISMA 2020 guidelines. The selection process included an identification stage to eliminate duplication, screening based on title and abstract, eligibility assessment based on full text, and an inclusion stage that resulted in 21 articles that met the criteria.

After selection, data extraction was carried out on the selected articles using Spreadsheet. The data collected included article identity, research objectives, research methods, and research results related to the effectiveness of the RADEC model in improving critical thinking skills of elementary school students. The data synthesis process was carried out descriptively, grouping the findings based on main themes such as the effectiveness of the RADEC model, the context of application in elementary schools, and the supporting and inhibiting factors in the RADEC model.

RESULT AND DISCUSSION

Development of critical thinking skills of elementary school students. A full summary of each article reviewed is presented in Appendix A (Table 3). Most of the studies (n = 18) stated that the model is effective in promoting mastery of higher order thinking skills, especially in science and IPAS subjects, as well as in various other contexts such as reading literacy, character education and student creativity. However, six articles (n = 6) explicitly mentioned barriers to RADEC implementation, such as limited student literacy, lack of teacher training

and lack of institutional support. In addition, three articles (n=3) reported that the effectiveness of RADEC was either low or not superior to other approaches, such as the Project-Based Learning (PjBL) model.

Table 3. Application of the RADEC Learning Model in Primary Schools

No	Author	Research Objectives	Research Methods	Research Results
1	(Maftuh et al., 2024)	Identifying the effectiveness and challenges of the RADEC model in developing 21st century skills	SLR (PRISMA 2020)	RADEC improves the 4Cs, but is constrained by student literacy and teacher readiness
2	(Tulljanah & Amini, 2021)	Evaluate the effectiveness of RADEC in science learning	Literature Review	RADEC effectively improves HOTS; technology combination improves results
3	(Yulianti et al., 2022)	Improving elementary students' critical thinking through RADEC	Quantitative (pretest-posttest)	Score increased significantly; active student participation plays an important role
4	(Rohmatillah et al., 2024)	Reviewing the effectiveness of RADEC in active learning	Literature Review	RADEC is effective, but hampered by teacher readiness and facilities
5	(Satria & Sopandi, 2019)	Assessing RADEC in improving critical thinking	Qualitative	Low effectiveness; needs teacher training and reinforcement strategies
6	(Zalukhu et al., 2024)	Assessing the effect of RADEC on science critical thinking	Quasi-experiment	RADEC improves learning outcomes and student interaction
7	(Pratama et al., 2019)	Analyzing RADEC on students' critical thinking	Qualitative SLR	RADEC promising, but needs teacher training support
8	(Salma Ihsani Fhilrizki et al., 2024)	Improving students' science literacy with RADEC	Pre-experimental	N-gain improvement 0.48; active and collaborative learning atmosphere
9	(Jumanto et al., 2024)	Develop RADEC-based IPAS teaching materials	R&D	Textbooks are valid and effective; obstacle: low student HOTS

10	(Henita & Zen, 2024)	Develop HOTS science teaching materials with RADEC	R&D (4D model)	High validity and effectiveness; increased participation and confidence
11	(Fatimah et al., 2024)	RADEC's effectiveness on reading comprehension	Quantitative (Post-test only)	Scores increased significantly compared to conventional methods
12	(Ifdaniyah & Sukmawati, 2024)	RADEC Effectiveness in Science and Social Studies	Quasi-experiment	RADEC effectively improves HOTS and science literacy
13	(Gunawan et al., 2024)	Effectiveness of RADEC in shape change materials	Pretest-posttest	HOTS score increased; N-gain 0.74 (high category)
14	(Tillah & Subekti, 2024)	RADEC's impact on science literacy and critical thinking	Quantitative descriptive	Significantly improved science literacy and critical thinking
15	(Syahrani et al., 2024)	RADEC evaluation on digestive system material	Quasi-experiment	Skor meningkat dari 55,9 ke 80,4 secara signifikan
16	(Lestari et al., 2022)	RADEC's influence on sustainability awareness	Pre-experimental	Significantly increase ESD awareness
17	(Yusuf et al., 2025)	RADEC's influence on creativity and innovation	Quasi-experiment	RADEC enhances students' creativity and HOTS skills
18	(Candraswari & Suniasih, 2024)	RADEC + Question Box in Science	Quasi-experiment	Improving critical thinking higher than control
19	(Pattimukay et al., 2023)	Flipped classroom on mathematical critical thinking	Quasi-experiment	Effective model; N-gain 93.34% (medium category)
20	(Khaerunnisa et al., 2025)	RADEC vs. PjBL on creativity and critical thinking	Quasi-experiment	PjBL more effective; RADEC less effective (N-gain 12.9%)
21	(Tarigan et al., 2024)	RADEC implementation in Civics learning	classroom action research (*PTK*)	Completion rate increased from 37% to 63%; scores increased significantly

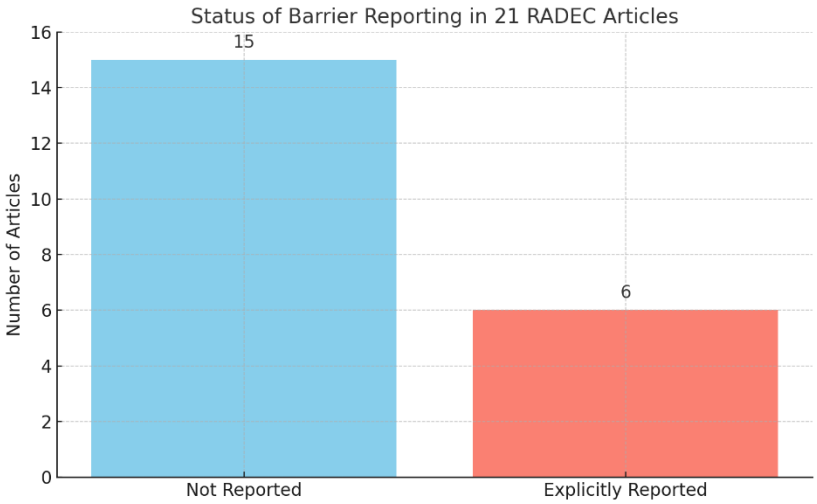
The characteristics of the 21 articles analyzed in this study show diversity in terms of methodological approaches, research subjects, as well as the implementation focus of the RADEC model. The majority of the articles used quasi-experimental methods or classroom action studies involving primary school students as the main subjects. The study areas covered various regions in Indonesia, indicating that the RADEC model has been widely adapted in the national primary education context. The main focus of the articles revolves around improving students' critical thinking skills, literacy, creativity and character values

through a systematic and structured approach. In addition, the articles also reflect variations in the application of RADEC to specific subjects such as Science, IPAS, Indonesian Language, to Civic Education, demonstrating the model's flexibility in different subject areas. Detailed information on the author, year of publication, research design, sample, as well as the main results of each study provide a strong foundation for this systematic analysis.

Table 4. Synthesis of RADEC Model Implementation Effectiveness and Barriers

No	Author(s)	Year	RADEC Effectiveness	Implementation Barriers	Barrier Status
1	Maftuh et al.	2024	Effective	Low student literacy	Reported
2	Tulljanah & Amini	2021	Effective	Not mentioned	Not reported
3	Yulianti et al.	2022	Effective	Not mentioned	Not reported
4	Rohmatillah et al.	2024	Effective	Inadequate facilities & institutions	Reported
5	Satria & Sopandi	2019	Less effective	Lack of teacher training	Reported
6	Zalukhu et al.	2024	Effective	Not mentioned	Not reported
7	Pratama et al.	2019	Effective	Need for teacher training	Reported
8	Salma Ihsani et al.	2024	Effective	Not mentioned	Not reported
9	Jumanto et al.	2024	Effective	Low student HOTS	Reported
10	Henita & Zen	2024	Effective	Not mentioned	Not reported
11	Fatimah et al.	2024	Effective	Not mentioned	Not reported
12	Ifdaniyah & Sukmawati	2024	Effective	Not mentioned	Not reported
13	Gunawan et al.	2024	Effective	Not mentioned	Not reported
14	Tillah & Subekti	2024	Effective	Not mentioned	Not reported
15	Syahrani et al.	2024	Effective	Not mentioned	Not reported
16	Lestari et al.	2022	Effective	Not mentioned	Not reported
17	Yusuf et al.	2025	Effective	Not mentioned	Not reported
18	Candraswari & Suniasih	2024	Effective	Not mentioned	Not reported
19	Pattimukay et al.	2023	Effective	Not mentioned	Not reported
20	Khaerunnisa et al.	2025	Less effective	Comparison with PjBL	Reported
21	Tarigan et al.	2024	Effective	Not mentioned	Not reported

Based on the synthesis of the effectiveness and barriers to implementation of the RADEC model presented in Table 4, it can be seen that the majority of articles reported positive effectiveness, despite some implementation constraints. To provide a clearer picture of the pattern of findings, the following diagram visualization presents the proportion of the number of articles based on the reported effectiveness and barriers.



Picture 2. Status of Barriers Reporting in 21 RADEC Articles

In the process of implementation in the field, the RADEC model is not entirely free from challenges. Based on a review of the articles analyzed, there are various obstacles faced by teachers and schools in implementing this approach optimally. One of the most frequently mentioned obstacles is students' low initial literacy, especially at the Read and Answer stages, which require the ability to understand texts and ask reflective questions. In addition, some studies have also highlighted the limited training teachers have received in fully understanding RADEC philosophy and practice, which has led to implementation not going as expected. Another contributing factor is the lack of institutional support in the form of time, facilities or a flexible curriculum to adapt RADEC components to classroom needs. The identification of these barriers is important to inform the development of more responsive education policies and to inform the design of ongoing professional training for teachers.

While some of the articles in this study identified barriers to the implementation of the RADEC model, others did not explicitly list them. To understand the reasons behind this absence, an in-depth analysis of the context and focus of each article was conducted. The following table summarizes the possible reasons for not mentioning barriers to RADEC implementation in the 15 articles reviewed.

Table 5. Analysis of Reasons for Not Mentioning Barriers to RADEC Model Implementation in the Reviewed Articles

No	Authors	Year	Barrier Status	Presumed Reason for Not Being Reported
2	Tulljanah & Amini	2021	Not mentioned	Study focuses more on learning outcomes than process analysis
3	Yulianti et al.	2022	Not mentioned	Quantitative research that does not explore implementation factors

6	Zalukhu et al.	2024	Not mentioned	Study limited to learning outcomes measurement without barrier review
8	Salma Ihsani et al.	2024	Not mentioned	Focused on effectiveness in a specific content context, not implementation process
10	Henita & Zen	2024	Not mentioned	Experiment-based study without reporting implementation barriers
11	Fatimah et al.	2024	Not mentioned	Main goal was to test learning outcomes, not analyze implementation
12	Ifdaniyah & Sukmawati	2024	Not mentioned	Discussion directed toward model effects, not implementation challenges
13	Gunawan et al.	2024	Not mentioned	Study highlights instructional design over implementation process
14	Tillah & Subekti	2024	Not mentioned	Did not explicitly address implementation dimension
15	Syahrani et al.	2024	Not mentioned	Study approach is more quantitative and output-oriented
16	Lestari et al.	2022	Not mentioned	Focused on improving skills without addressing barriers
17	Yusuf et al.	2025	Not mentioned	Analysis limited to model's influence on student outcomes
18	Candraswari & Suniasih	2024	Not mentioned	No contextual exploration of implementation barriers
19	Pattimukay et al.	2023	Not mentioned	Study did not identify issues or implementation challenges
21	Tarigan et al.	2024	Not mentioned	Research focuses more on outcome achievements than implementation aspects

While six articles explicitly mentioned barriers to the implementation of the RADEC model - such as low student literacy, lack of teacher training and institutional readiness - most of the remaining articles (n = 15) did not reveal any barriers. This absence of information can be explained by several possibilities. Some studies had a primary focus on measuring effectiveness without exploring contextual aspects or field constraints, as seen in purely quantitative or experimental research (e.g. by Tulljanah & Amini, Yulianti et al., and Yusuf et al.). In addition, there are articles that focus on the development of teaching tools or supporting media without including reflection on the implementation process in real classrooms (such as Henita & Zen, and Fatimah et al.). Thus, the absence of reports on barriers does not mean that these challenges do not exist, but rather the limited scope of the study or the methodology used by the researchers.

Most of the findings show that the RADEC model is able to encourage active, reflective, and student-centered learning through the Read, Answer, Discuss, Explain, and Create stages. The discussion and presentation stages are proven to improve students' argumentation and logical thinking skills, while the Create stage fosters contextual application of knowledge through real products. RADEC's success in improving critical thinking skills is not only limited to science subjects, but is also reflected in the strengthening of reading literacy (Fatimah et al., 2024), science literacy (Salma Ihsani Fhilrizki et al., 2024), as well as student creativity and innovation (Yusuf et al., 2025).

On the other hand, the main obstacles found in some studies relate to students' low reading literacy, teachers' readiness to manage the RADEC model, and lack of facilities and institutional support. These challenges generally arise in the early stages (Read and Answer) which rely on the ability to understand the text independently. Meanwhile, the successful implementation of RADEC relies heavily on teachers' competence in developing contextualized and participatory learning strategies (Satria & Sopandi, 2019). In addition, some articles show that the effectiveness of RADEC still varies when compared to other approaches such as PjBL, especially in the context of developing creativity (Khaerunnisa et al., 2025). This suggests that RADEC's effectiveness is strongly influenced by subject characteristics, student readiness and institutional support.

CONCLUSION

The systematic review affirms that the RADEC learning model is effective in enhancing the critical thinking skills of elementary school students. Through its five structured stages—Read, Answer, Discuss, Explain, and Create—the model fosters student engagement, deepens conceptual understanding, and develops essential 21st-century competencies. Its implementation encourages reflective and collaborative learning that aligns well with current educational demands. Nonetheless, the successful application of the RADEC model requires more than merely following its procedural steps. It necessitates adequate preparation in terms of students' literacy readiness, teachers' pedagogical competence, and institutional support. These factors play a crucial role in ensuring the model's effectiveness and sustainability in real classroom settings.

To ensure its optimal use, educational stakeholders must collaboratively support the conditions required for RADEC's success. Teachers need to continuously adjust learning strategies based on students' needs and context. Simultaneously, schools and policymakers must provide adequate professional development opportunities and infrastructure. Moreover, future research should examine the integration of RADEC with digital technologies and its adaptation across a broader range of subjects. By addressing these aspects, the RADEC model can contribute more meaningfully to improving the quality of education in primary schools.

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