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The RADEC Model for Enhancing Higher-Order Thinking Skills (HOTS) in Elementary School Students: A Systematic Literature Review

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Abstract

Strengthening Higher-Order Thinking Skills (HOTS) in elementary school students requires instruction that facilitates analysis, evaluation, problem-solving, and idea generation. This study aims to analyze the characteristics of the included studies, the direction and strength of empirical evidence, as well as the factors supporting and hindering the implementation of Read, Answer, Discuss, Explain, and Create (RADEC) in the development of HOTS. The study employed a Systematic Literature Review (SLR) based on PRISMA 2020. Articles published between 2021 and 2025 were retrieved through Google Scholar and Scopus with the assistance of Publish or Perish. Inclusion criteria included primary empirical studies on elementary school students that addressed RADEC and HOTS or their indicators, were published in journals indexed by Scopus and/or accredited at SINTA levels 1-4, were written in Indonesian or English, and were available in full text; articles that did not meet these criteria were excluded. Of the 437 documents, 24 articles met the criteria and were analyzed using descriptive coding, narrative synthesis, and thematic synthesis. All studies originated from the Indonesian educational context; 87.5% were published between 2023 and 2025, and 87.5% focused on grades IV-V. The evidence points to a positive trend, but the inferential strength varied across studies. Comparative evidence more consistently favored RADEC over conventional instruction, whereas comparisons with PBL yielded mixed findings. The implementation of RADEC depends on the readiness of the Read-Answer phase, the quality of the Discuss-Explain phase, as well as the time allocated and scaffolding provided during the Create phase. RADEC shows potential in supporting the development of HOTS; however, current evidence does not support claims of universal superiority or generalization.

Keywords: RADEC; HOTS; elementary school; Systematic Literature Review; PRISMA

INTRODUCTION

Changes in learning needs in the 21st century require the strengthening of Higher-Order Thinking Skills (HOTS) starting in elementary school. Learning is no longer sufficient if it is focused solely on the ability to memorize and understand information; rather, it must provide students with opportunities to analyze, evaluate, solve problems, and generate ideas based on their existing knowledge. In the revised Bloom's taxonomy, higher-order thinking processes are primarily associated with the abilities to analyze (C4), evaluate (C5), and create (C6) (Shalikhah & Nugroho, 2023; Tulljanah & Amini, 2021). HOTS is also related to the ability to transfer knowledge, think critically, and solve problems so that knowledge is not merely mastered but can be applied to various situations (Brookhart, 2010). Therefore, strengthening HOTS in elementary school students is crucial for developing the ability to process information, provide reasoning, make decisions, and solve problems in a more reflective manner.

However, the development of HOTS in elementary school education still faces various obstacles. A review by Shalikhah and Nugroho (2023) of 11 articles indicates that the implementation of HOTS in elementary schools needs to be supported in an integrated manner through instructional models, media, and assessment, whereas its application has not yet been optimal across all these aspects. Alditia et al. (2024) further identified barriers to the development of critical thinking in elementary school Natural Science education related to students' internal factors and teacher quality, including low motivation and participation, underdeveloped independent learning skills, a lack of familiarity with tasks requiring higher-order thinking, teaching that remains teacher-centered, and limited use of appropriate models, media, and assessments to support critical thinking. In a more limited local context, Sari et al. (2023) found that out of 20 fourth-grade students at an elementary school in Magetan Regency, East Java, 14 students fell into the low critical thinking ability category and six into the moderate

category, with no students in the high category, while evaluation showed the lowest level of achievement among the critical-thinking indicators. Given that this study involved only one school with a limited sample size, these findings are used to illustrate local conditions and should not be generalized to represent all elementary school students. Taken together, these various findings highlight the need for instruction that systematically provides opportunities for students to build prior knowledge, process information, articulate reasons, evaluate ideas, and generate solutions.

One learning model relevant to these needs is Read, Answer, Discuss, Explain, and Create (RADEC). The RADEC model organizes learning through five stages: reading the material before the lesson (Read), answering pre-learning questions independently (Answer), discussing the answers (Discuss), explaining and clarifying the results of the discussion (Explain), and using knowledge to generate ideas, solutions, or products (Create) (Sopandi et al., 2023). Conceptually, the Read and Answer stages help build prior knowledge and readiness for learning; Discuss and Explain provide opportunities to compare information, present reasons, respond to different perspectives, and refine understanding, while Create encourages the productive application of knowledge. This sequence aligns with the HOTS concept, which encompasses knowledge transfer, critical thinking, and problem-solving (Brookhart, 2010). Thus, the relevance of RADEC to HOTS lies not only in the Create stage but also in the cognitive activities facilitated sequentially throughout the entire learning sequence.

A number of empirical studies generally report positive results regarding the application of RADEC in supporting HOTS or HOTS indicators among elementary school students, including critical thinking, creative thinking, and HOTS in general (Damayanti et al., 2023; Nadia et al., 2023; Sarira et al., 2024; Widodo et al., 2024). Nevertheless, these studies exhibit diverse methodological characteristics. Some employ experimental or quasi-experimental designs with

a comparison group, while others utilize pre-experimental designs, classroom action research, single-subject research, Rasch-based analysis, development research, design-based research, or qualitative approaches. The outcomes, instruments, participant characteristics, types of comparison groups, and forms of RADEC implementation also differ across studies. Therefore, evidence regarding RADEC cannot be adequately interpreted solely through the assertion that the model is "effective"; the direction of the findings must be considered alongside the strength of inference and the nature of the evidence generated by each research design.

Previous systematic reviews have provided an important foundation, but they have addressed aspects of RADEC from different perspectives. Tulljanah and Amini (2021) examined RADEC as an alternative for enhancing Higher-Order Thinking Skills (HOTS), specifically in elementary school Natural Science education, by reviewing six relevant publications and emphasizing the relationship between the RADEC syntax and HOTS. Andriyani et al. (2024) analyzed 10 articles obtained through SINTA with a specific focus on critical thinking skills and reported a positive trend in the application of RADEC on these abilities. Meanwhile, Burhanudin et al. (2024) used PRISMA 2020 and reviewed 26 articles from 2019-2023 with a broader scope, covering the RADEC learning process, 21st-century skills related to its implementation, and the challenges of applying RADEC in elementary schools. Thus, the previous studies each focused on HOTS in Natural Science learning, critical thinking specifically, and 21st-century skills and the implementation of RADEC within a broader scope.

A remaining research gap concerns the absence of an integrated synthesis that simultaneously maps the characteristics of the evidence base, examines the direction and relative strength of empirical evidence, and synthesizes the conditions shaping RADEC implementation specifically in relation to HOTS among elementary school students. The three

previous reviews did not explicitly distinguish the strength of inference across studies using comparison groups, single-group pretest-posttest designs, classroom action research, single-subject research, and development studies that primarily provided evidence of validity or practicality. Findings that similarly indicate positive outcomes do not necessarily provide an equivalent basis for inference. Moreover, the interpretation of RADEC-related outcomes needs to consider the implementation conditions across the Read-Answer, Discuss-Explain, and Create stages, including student readiness, quality of interaction, teacher facilitation, time allocation, and task characteristics. The novelty of the present study therefore lies in integrating these three dimensions so that RADEC's contribution to HOTS can be interpreted according to the characteristics of the evidence and its implementation context rather than simply categorized as effective or ineffective.

Based on these gaps, this study aims to provide a more comprehensive synthesis of research developments, the direction and strength of empirical evidence, and the implementation of RADEC in the development of HOTS among elementary school students during the 2021-2025 period. Specifically, the study is designed to answer three research questions, namely: (RQ1) What are the trends in publications and the characteristics of RADEC-HOTS research on elementary school students based on year of publication, research design, subject, grade level, and HOTS indicators?; (RQ2) What are the direction and strength of the empirical evidence regarding RADEC's contribution to the development of HOTS or HOTS indicators among elementary school students, based on the nature and indicators of the outcomes reported in each study?; and (RQ3) What factors support and hinder the implementation of RADEC in the development of HOTS among elementary school students?.

RESEARCH METHOD

This study used the Systematic Literature Review (SLR) method to identify, select, evaluate,

and synthesize empirical research on the Read, Answer, Discuss, Explain, and Create (RADEC) model in the development of Higher-Order Thinking Skills (HOTS) or HOTS indicators among elementary school students. The process of identifying and selecting articles followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines, which include the stages of identification, screening, eligibility, and inclusion (Page et al., 2021). A systematic literature review (SLR) was chosen because this study not only maps the development of publications but also compares methodological characteristics, examines the direction and strength of empirical evidence, and synthesizes factors supporting and hindering the implementation of RADEC. Data were analyzed using descriptive coding, narrative synthesis, and thematic synthesis according to the nature of each research question (Centre for Reviews and Dissemination, 2009; Sinha et al., 2022; Zawacki-Richter et al., 2020).

The review included scientific journal articles discussing the RADEC model and HOTS or HOTS indicators among elementary school students. The search was conducted via Google Scholar and Scopus with the assistance of the Publish or Perish (PoP) application as a tool for searching and documenting search results. The search used the Title Word "RADEC" along with a combination of Keywords ("HOTS" OR "berpikir tingkat tinggi" OR "higher order thinking skills") AND ("sekolah dasar" OR "elementary school" OR "primary school"). The Boolean operator OR was used to capture variations of terms with equivalent meanings, while AND was used to link the main concepts of the study (Booth et al., 2016). The search was limited to publications from 2021 to 2025, with the "Maximum Results" setting set to 1,000 documents in PoP.

Inclusion and exclusion criteria were applied consistently to determine the eligibility of articles. These criteria included year of publication, type and index of publication, research focus, subject or educational level, language, and availability of the full text, as presented in Table 1.

Table 1. Article Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Year of Publication	Articles published between 2021 and 2025	Articles published before 2021 or after 2025
Publication Type	Scientific journal articles in the form of primary empirical research	Theses, dissertations, conference proceedings, books, review articles, and non-journal publications
Publication Index	Journals indexed in Scopus and/or accredited by SINTA 1-4	Journals not indexed in Scopus and not accredited by SINTA 1-4
Research Focus	Discusses the application of RADEC and directly measures HOTS or HOTS indicators	Does not implement RADEC or only measures other outcomes that do not directly represent HOTS
Subject/Grade Level	Elementary school students or equivalent levels	Subjects other than elementary school students or equivalent levels
Language	Indonesian or English	Languages other than Indonesian and English
Availability	Full text is available and verifiable	Full text is not available or the source cannot be adequately verified

The selection process was conducted in stages to ensure that potentially relevant articles were not excluded too early. During the identification stage, 437 documents were obtained, consisting of 417 from Google Scholar and 20 from Scopus. A total of 31 documents were identified as duplicates and excluded, leaving 406 documents to proceed to the screening stage. At this stage, the titles, abstracts, and keywords were examined to assess initial relevance to RADEC, the elementary education level, and HOTS or indicators potentially related to HOTS. Screening was conducted relatively broadly to retain articles for which metadata alone did not allow for a definitive determination of eligibility.

Based on this screening, 342 documents were excluded because they did not demonstrate sufficient relevance to the scope of the study, while 64 documents proceeded to the eligibility phase. Unlike the screening phase, the eligibility stage involved a full-text review in which all

inclusion and exclusion criteria were strictly applied. This review was necessary because the suitability of outcomes, subject characteristics, study types, publication indices, and forms of RADEC implementation cannot always be determined based solely on article metadata.

Of the 64 articles reviewed in full, 40 were excluded, with a single primary exclusion reason assigned to each article to prevent double counting. A total of 16 articles were excluded because the primary outcome did not directly measure HOTS or HOTS indicators; 11 articles did not meet the Scopus or SINTA 1-4 publication index criteria; six articles were not primary empirical studies or were not journal articles; four articles did not meet the criteria for subject, educational level, or language; and three articles lacked full-text versions or sufficiently verifiable sources. Consequently, 24 articles met all criteria and were designated as the final research corpus. The article identification and selection process is presented in Figure 1.

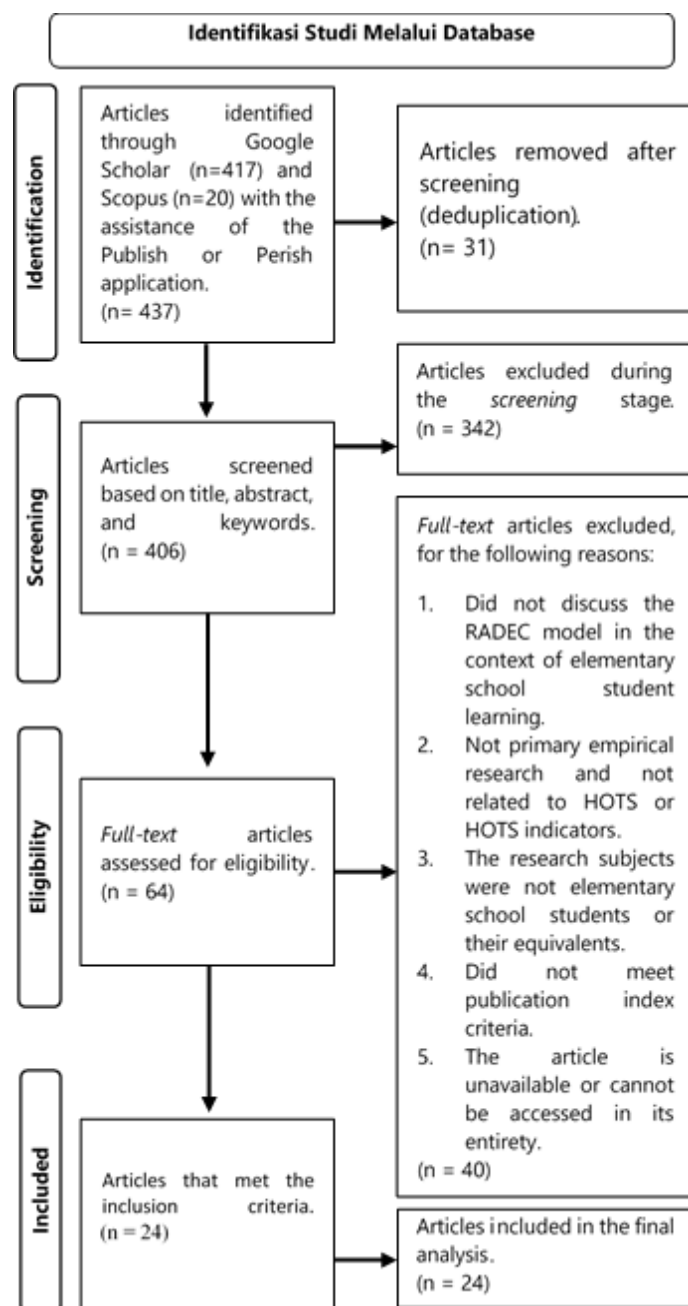


Figure 1. Article Selection Flowchart Based on PRISMA 2020

Each article that met the inclusion criteria was then examined with regard to six aspects of reporting quality that could affect the strength of evidence interpretation, namely: (1) clarity of the research objectives; (2) clarity of the research design or methods; (3) clarity of the research subjects or participants; (4) clarity of data collection instruments and procedures; (5) clarity of data analysis techniques; and (6) consistency between the reported results and the study's conclusions (Sinha et al., 2022). These six aspects were used as an interpretive lens rather than as a

formal per-article scoring instrument: no categorical rating (e.g., met, partially met, or not met) was assigned to individual articles, and no composite quality score was calculated. Instead, these considerations informed the narrative judgments made during synthesis. They were not used to exclude any article that had already met the eligibility criteria.

Data extraction was conducted systematically on the 24 selected articles using an extraction form designed to address the three research questions. The information collected included article identifiers, year of publication, journal index, research design, number and grade level of participants, subject context, form of RADEC implementation, HOTS indicators examined, measurement instruments, primary outcomes, reported outcome indicators, the presence of a comparison group, and factors supporting and hindering implementation. Variations in the application of the RADEC framework were also noted to identify potential heterogeneity in implementation across studies.

Data were analyzed through descriptive coding, narrative synthesis, and thematic synthesis. To address RQ1, descriptive coding was used to map trends and characteristics of the studies based on year of publication, research design, subject area or learning context, grade level, and HOTS indicators. The coding results were presented as counts and percentages to illustrate trends and gaps in the research during the 2021-2025 period.

To answer RQ2, narrative synthesis was used to examine the direction and relative strength of empirical evidence regarding RADEC's contribution to HOTS or HOTS indicators based on the results reported in each study, such as N-gain, significance values, mean differences, changes in proficiency levels, logit values, and effect sizes when available. The interpretation took into account study design, the presence and type of comparison groups, measurement instruments, and the completeness of statistical reporting. Therefore, evidence of validity or practicality from developmental studies was not treated on par with comparative evidence from

experimental or quasi-experimental studies. Similarly, pretest-posttest changes without a comparison group were not interpreted as having the same inferential power as between-group differences.

N-gain values and other statistics were not combined into a single overall effect estimate because the analyzed articles exhibited substantial heterogeneity in research design, measured outcomes, instruments, comparison groups, intervention duration, participant characteristics, and statistical reporting formats. Thus, the review focused on synthesizing the direction, consistency, and relative strength of the available evidence, rather than on calculating a combined effect as is done in a meta-analysis.

To address RQ3, a thematic synthesis was used to identify factors supporting and hindering the implementation of RADEC. Findings were grouped based on their relevance to the Read-Answer, Discuss-Explain, and Create stages, as well as contextual factors influencing overall implementation, such as student readiness, the teacher's role and facilitation, time management, the use of media and technology, and the characteristics of learning activities. Variations in the application of the RADEC syntax across studies were also considered so that it would not be assumed that all studies implemented RADEC in a completely identical manner.

RESULT AND DISCUSSION

A total of 24 articles that met all inclusion criteria were analyzed to answer the three research questions. Study characteristics were mapped through descriptive coding to answer RQ1; the direction and strength of empirical evidence regarding RADEC were synthesized narratively to answer RQ2; and factors supporting and hindering implementation were analyzed thematically to answer RQ3. All selected articles were derived from studies conducted within the context of Indonesian education. Therefore, the synthesis results in this study represent the development and empirical evidence of RADEC-HOTS in elementary schools in Indonesia and are

not intended as a basis for direct generalization to education systems in other countries.

RQ1. Publication Trends and Characteristics of RADEC-HOTS Research

The first research question aimed to map publication trends and characteristics of RADEC-HOTS research on elementary school students based on year of publication, research design, grade level, subject or learning context, and HOTS indicators. This mapping was used to illustrate trends while identifying research concentrations and gaps within the analyzed corpus.

Table 2. Characteristics of 24 Selected Articles

No.	Author (Year)	Research Design	Grade Level	Subject/Context	HOTS Indicators
1	Suryana et al. (2021)	Descriptive qualitative	V	Natural Science	Creative thinking
2	Yulhaqqi and Amini (2022)	ADDIE R&D Model	IV	Natural Science	Critical thinking
3	Pratama and Dewi (2022)	Two-cycle online action research	IV	Theme 8/ Indonesian Language	HOTS C6
4	Fitri et al. (2023)	4-D R&D Model	V	Natural Science	HOTS
5	Sapitri et al. (2023)	Two-cycle action research	V	Natural Science	Critical thinking
6	Nurliana and Sukmawati (2023)	Quantitative based on Rasch stacking	V	Natural Science	Creativity
7	Nadia et al. (2023)	Quasi-experimental	IV	Natural Science/ Natural and Social Sciences	HOTS
8	Rifatunnisa et al. (2023)	Two-cycle action research	V	Civics Education	Critical thinking
9	Damayanti et al. (2023)	A-B-A-B Single-Subject Design	V	Natural Science/ Natural and Social Sciences	HOTS
10	Fauziah and Sukmawati (2023)	Descriptive quantitative analysis based on Rasch stacking	V	Natural Science	HOTS
11	Yuniasih et al. (2024)	Descriptive qualitative	V	Natural Science	Creative thinking
12	Henita et al. (2024)	4-D R&D Model	IV	Natural Science	HOTS

No.	Author (Year)	Research Design	Grade Level	Subject/Context	HOTS Indicators
13	Jumanto et al. (2024)	ADDIE R&D Model	IV	Natural and Social Sciences	Critical and creative thinking
14	Sarira et al. (2024)	Quasi-experimental	III	Thematic Learning	HOTS
15	Nurafifah et al. (2024)	Quasi-experimental	V	Natural Science	Creative thinking
16	Muthmainah et al. (2024)	Pre-experimental	IV	Natural Science	Critical thinking
17	Widodo et al. (2024)	Quasi-experimental	VI	Natural Science /Solar System	HOTS C4-C6
18	Widyarti et al. (2024)	Three-cycle action research	V	Natural Science	Creative thinking
19	Romdoni and Salam (2024)	Pre-experimental	IV	Natural Science	Critical thinking
20	Setiawan et al. (2024)	3 × 2 factorial experiment	IV	Natural and Social Sciences	Critical thinking
21	Anggraeni et al. (2024)	Design-Based Research	V	Natural Science /Environmental Change	6Cs, including critical thinking and creativity
22	Latifa et al. (2025)	Quasi-experimental	IV	Natural Science	Critical thinking
23	Insani et al. (2025)	Quasi-experimental	IV	Social Studies	Critical thinking
24	Afiyah et al. (2025)	Quasi-experimental	VI	Natural Science/ Natural and Social Sciences	HOTS C4-C5

Table 2 shows that RADEC-HOTS research exhibits diversity in design, grade levels, learning contexts, and ability indicators, but the distribution is not yet even. Based on the year of publication, one article (4.2%) was published in 2021, two articles (8.3%) in 2022, seven articles (29.2%) in 2023, eleven articles (45.8%) in 2024, and three articles (12.5%) in 2025. Thus, 21 out of 24 articles (87.5%) were published during the 2023-2025 period, with the highest number of publications in 2024. This distribution indicates that research on RADEC-HOTS within the study corpus is relatively concentrated in the last three

years; however, this should not be interpreted as a linear upward trend because the number of articles varies from year to year.

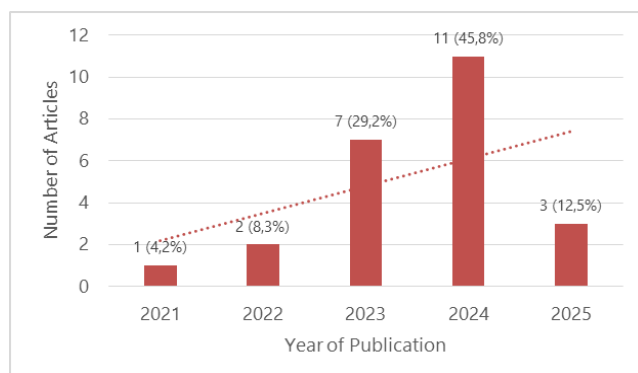


Figure 2. Trends in RADEC-HOTS Research Publications, 2021-2025

In terms of research design, quasi-experimental designs were the most commonly used, with seven studies (29.2%). Developmental research and classroom action research were each found in four studies (16.7%). Pre-experimental designs, Rasch stacking-based research, and descriptive qualitative studies were each used in two studies (8.3%), while factorial experiments, single-subject research, and design-based research were each found in one study (4.2%). This composition indicates that the RADEC-HOTS evidence base is built through a heterogeneous methodological approach. Consequently, the types of conclusions that can be drawn also differ; studies with comparison groups provide a comparative basis, whereas action research, development research, Rasch studies, single-subject research (SSR), and qualitative research primarily provide information regarding changes within specific contexts, the feasibility of instruments, patterns of individual development, and implementation processes. These differences in the nature of the evidence serve as the basis for assessing the strength of inferences more proportionally in RQ2.

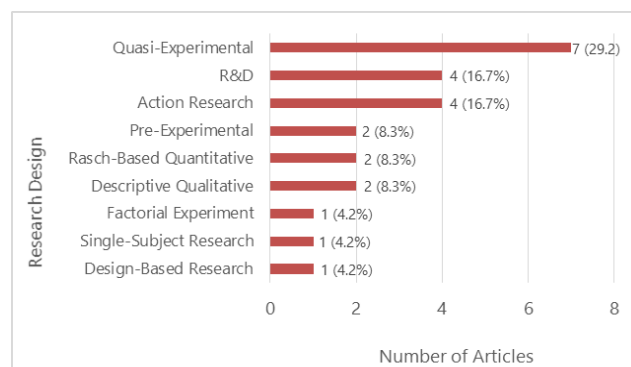


Figure 3. Distribution of Research Designs Across 24 RADEC-HOTS Articles

Grade-level characteristics indicate a concentration of research in grades IV and V. A total of 10 studies (41.7%) were conducted in grade IV and 11 studies (45.8%) in grade V, meaning these two grade levels account for 21 of the 24 articles (87.5%). Grade III is represented by only one study (4.2%), while Grade VI is represented by two studies (8.3%). No research was found for Grades I and II. This indicates that the evidence base for RADEC-HOTS still relies heavily on upper-grade students, particularly Grades IV and V, meaning its application to lower grades lacks sufficient empirical support in this corpus.

A concentration was also observed in subject contexts. Based on the classification of the 24 articles, 20 studies (83.3%) were conducted in Natural Science, Natural and Social Sciences, or closely related science-oriented contexts, while applications in Indonesian Language, Civics Education, Thematic Learning, and Social Studies were found in more limited numbers. Nevertheless, research on Civics Education and Social Studies indicates that RADEC is not limited to science instruction. These findings suggest the potential for application in non-science subjects; however, the available evidence remains insufficient compared to that for Natural Science and Natural and Social Sciences.

When examined based on the skills assessed, nine studies (37.5%) identified HOTS in general as the primary outcome, eight studies (33.3%) focused on critical thinking, and five studies (20.8%) focused on creativity or creative thinking. One study (4.2%) measured critical and creative thinking simultaneously, while one study (4.2%)

integrated both skills into the 6Cs construct. Thus, general HOTS and critical thinking accounted for 17 of the 24 articles (70.8%), while critical thinking was the most frequently examined specific HOTS indicator. This pattern indicates that research on other dimensions of HOTS remains more limited.

Another important characteristic is that all 24 selected articles originated from the Indonesian educational context. Studies were conducted in various regions, but no research was found in the corpus that tested RADEC-HOTS in educational systems outside Indonesia. Therefore, the results of this study are best understood as a snapshot of the evidence base for RADEC-HOTS in elementary schools in Indonesia and should not be directly generalized to the educational contexts of other countries.

Overall, the findings of RQ1 indicate that RADEC-HOTS research has expanded to include various study designs and competency indicators; however, the evidence base remains concentrated in the 2023-2025 period, grades IV-V, Natural Science and Natural and Social Sciences learning contexts, and elementary education in Indonesia. These findings complement previous studies focusing on RADEC in Natural Science learning and critical thinking by more specifically highlighting the structure and limitations of the available research corpus. Thus, future research needs to expand the scope to lower grades, non-science subjects, and educational contexts outside Indonesia so that the consistency of RADEC's benefits can be tested under more diverse conditions.

RQ2. Direction and Strength of Empirical Evidence Regarding RADEC's Contribution to HOTS

The second research question aimed to examine the extent to which empirical evidence supports the effectiveness of RADEC in developing HOTS or HOTS indicators among elementary school students in Indonesia. The interpretation is based not only on the reported results but also takes into account the research design, the presence and type of comparison groups, the measurement patterns, the outcomes

assessed, and the statistical rigor of each study. These considerations are necessary because the studies in the corpus present heterogeneous types of evidence; thus, score increases, N-gain, inter-cycle results, logit changes, and product validity cannot be treated as evidence with the same inferential strength.

Table 3. Characteristics and Strength of Empirical Evidence for RADEC Regarding HOTS or HOTS Indicators

Characteristics of the Evidence	Study	Pattern of Findings	Interpretation of Evidence Strength
Studies with a comparison group	Afiyah et al. (2025); Insani et al. (2025); RADEC Latifa et al. (2025); Nadia et al. (2023); Nurafifah et al. (2024); Sarira et al. (2024); control group. Setiawan et al. (2024); However, Widodo et al. (2024)	Most studies show that the RADEC group achieved better outcomes or greater improvement compared to the control group. However, this outcome is not consistent when the control group also uses active learning models.	These provide the most direct comparative evidence, or although conclusions must consider the type of comparator, and statistics.
Studies reporting pretest-posttest changes without an equivalent comparison group	Muthmainnah et al. (2024); Romdoni and Salam (2024); Henita et al. (2024); Jumanto et al. (2024)	Abilities improved after the implementation of RADEC or the use of RADEC-based tools.	Changes were observed after the intervention, but these changes cannot be fully attributed to RADEC because there was no equivalent comparison group.
Action Research and Single-Subject Research	Damayanti et al. (2023); Pratama and Dewi (2022); Rifatunnisa et al. (2023); Sapitri et al. (2023); Widyarti et al. (2024)	Development is observed across cycles between the baseline and intervention phases.	Provides evidence of progress and the implementation of specific classroom or subject contexts, but offers a weaker basis for comparative or causal inference.
Rasch and descriptive/qualitative studies	Fauziah and Sukmawati (2023); Nurliana and Sukmawati (2023); Suryana et al. (2021)	Changes are evident through stacking/logit models or the development of creative thinking and HOTS.	Useful for explaining individual patterns and dimensions of ability, but not as

Characteristics of the Evidence	Study	Pattern of Findings	Interpretation of Evidence Strength
	Yuniasih et al. (2024)		comparative causal evidence.
Evidence of feasibility for development/ implementation	Anggraeni et al. (2024); Fitri et al. (2023); Yulhaqqi and Amini (2022)	The product is deemed valid, practical, and feasible, and its implementation demonstrates positive responses or ability profiles.	This indicates the product's readiness and the feasibility of its implementation, but does not constitute evidence of HOTS effectiveness equivalent to that found in comparative studies.

Studies with a comparison group provide a relatively stronger empirical basis for assessing changes related to the implementation of RADEC. In several studies that used conventional instruction as the comparator, the results consistently showed a favorable trend for the RADEC group. Nadia et al. (2023) reported a HOTS N-gain of 69.07% in the RADEC group compared with 33.48% in the group receiving conventional instruction. Widodo et al. (2024) similarly reported N-gain values of 0.75 for the RADEC group and 0.38 for the conventional-instruction group, while Latifa et al. (2025) reported N-gain values of 62% for the RADEC group and 33% for the group receiving conventional instruction. A similar pattern was found by Sarira et al. (2024) among third-grade students, with an average posttest score of 80.48 in the RADEC group compared to 67.50 in the control group and an N-gain of 61.9% in the experimental group. These findings indicate that comparative evidence against conventional instruction generally favors RADEC in terms of HOTS achievement or HOTS-related outcomes.

However, the RADEC model's advantage does not follow the same pattern when compared to active learning models. Insani et al. (2025) for example, compared RADEC with Problem-Based Learning (PBL) in social studies instruction and reported an N-gain for critical thinking of 0.63 in the RADEC group and 0.46 in the PBL group, with

a significant difference in improvement. Conversely, Setiawan et al. (2024) found an average critical thinking score of 86.67 in the RADEC group and 86.67 in the PBL group, while the Direct Instruction group scored 75.42. An ANOVA test indicated differences based on the learning model, but the article did not present post-hoc tests proving that RADEC was statistically superior to PBL. Therefore, the primary authors' conclusion that RADEC is more effective than PBL was not directly incorporated into this synthesis. With respect to this last aspect, the consistency between the results and conclusions of that study should be interpreted with caution.

The difference in results between Insani et al. (2025) and Setiawan et al. (2024) is a key finding in this review because it shows that RADEC's comparative advantage is not uniform when compared to other active models such as PBL. RADEC demonstrates more consistent advantages when compared with conventional instruction or Direct Instruction, whereas comparisons with PBL yield less consistent findings across contexts. These differences cannot yet be explained as the result of a single specific factor because the two studies differ in terms of subject matter, design, instruments, and measurement procedures. Thus, the effectiveness of RADEC is best understood by considering the type of comparison model and the context of its implementation, rather than as universal superiority over all learning models.

Similar caution is warranted when interpreting the results of Nurafifah et al. (2024) and Afiyah et al. (2025). In the study by Nurafifah et al. (2024), the N-gain of 0.72 in the experimental group and 0.31 in the control group reflects conceptual understanding, not creativity. Creativity was assessed separately through student products, while Kendall's W of 0.92 indicates inter-rater agreement and is not a measure of the magnitude of the RADEC effect on creativity. Therefore, this value is not used to indicate the extent of the increase in creativity. Meanwhile, Afiyah et al. (2025) used the Read-Answer-Discuss-Evaluate-Create syntax rather than the canonical Read-

Answer-Discuss-Explain-Create syntax; thus, their findings remain relevant as a RADEC-based variant but are not assumed to have a fully identical implementation mechanism.

Studies without a comparison group also showed positive changes following RADEC implementation, but their strength of causal inference was more limited. Muthmainnah et al. (2024) reported an increase in the mean critical thinking score from 38.7 to 88.2 with an N-gain of 0.80, while Romdoni and Salam (2024) found a significant pretest-posttest difference with an N-gain of 0.5825. A development study by Henita et al. (2024) also reported an average increase from 48.7 to 88.23 with an N-gain of 76.1, while Jumanto et al. (2024) demonstrated changes in critical and creative thinking skills following the use of RADEC-based instructional materials. However, since these studies did not use equivalent comparison groups, the results are more appropriately interpreted as changes following the intervention rather than as causal evidence that the changes were entirely due to RADEC. In the case of Henita et al. (2024) interpretation must also be done with caution due to several limitations regarding the consistency of reporting on procedures, effectiveness, and conclusions.

Evidence from classroom action research, single-subject research, Rasch analysis, and qualitative studies reinforces the picture that skill development occurs gradually and is not always uniform across students. Sapitri et al. (2023) noted that the mastery of critical thinking increased from 35% in the pre-intervention phase to 61.3% in Cycle I and 87% in Cycle II; Pratama and Dewi (2022) reported that the mastery of Higher-Order Thinking Skills (HOTS) increased from 37.1% to 80% and 94.2%, while Widyarti et al. (2024) found an increase in creative thinking from 67.27% to 81.73% and 86.63%. Rifatunnisa et al. (2023) also demonstrated progress in proficiency from approximately 12% on the pretest to 37% in Cycle I and 63% in Cycle II. Rasch-based research and qualitative studies then provide complementary information regarding variations in individual development

and dimensions of ability, including the finding that fluency and elaboration tend to develop more easily than originality. This type of evidence is useful for explaining developmental processes but provides a weaker basis for comparative or causal inference than controlled studies.

Development studies that primarily measure validity and practicality need to be distinguished from evidence of effectiveness. Yulhaqqi and Amini (2022) and Fitri et al. (2023) primarily demonstrated that RADEC-based tools meet validity and practicality criteria, while Anggraeni et al. (2024) reported a product validity of 90.7%, teacher and student activities in the "highly practical" category, and student 6Cs profiles in the "high" category. These findings support the readiness of the tools and the feasibility of their implementation, but they cannot be treated as evidence of HOTS effectiveness equivalent to that from comparative studies. Anggraeni et al. (2024) themselves suggest testing effectiveness on a larger scale.

Overall, the available empirical evidence in the context of Indonesian elementary education points to a generally positive trend regarding the development of HOTS or HOTS indicators following the implementation of RADEC. Nevertheless, the strength of the evidence varies depending on the study design, comparison group, outcomes, instruments, and form of implementation. The most consistent favorable comparative pattern was observed when RADEC was compared with conventional instruction, whereas its superiority over active models such as PBL was not consistently demonstrated. These findings suggest that the primary contribution of this synthesis is not merely to assert that RADEC is effective, but to demonstrate that the direction of RADEC's benefits is relatively consistent, while the magnitude of change and its comparative advantages are contextual. Therefore, based on the available evidence from Indonesia, RADEC is more appropriately positioned as a promising model for supporting HOTS, rather than as a model that has been proven to be universally superior to all other learning alternatives.

RQ3. Factors Supporting and Hindering the Implementation of RADEC

The third research question aimed to identify the factors that support and hinder the implementation of RADEC in the development of HOTS among elementary school students. The thematic synthesis indicates that these factors are related to the quality of activities in the Read-Answer, Discuss-Explain, and Create stages, as well as contextual conditions such as student readiness, the teacher's role, classroom management, time, and technological support.

Table 4. Factors Supporting and Hindering the Implementation of RADEC

Stage/aspect	Supporting factors	Inhibiting factors	Supporting studies
Read-Answer	Guided materials; learning questions; e-worksheets/e-modules; instructions; opportunities independent learning	Pre-learning pre- assignments completed; differences in student readiness; limitations on data allowances, internet access, or devices	Muthmainna et al. (2024); Pratama and Dewi (2022); Yulhaqqi and Amini (2022)
Discuss-Explain	Structured role assignments; opportunities to present and arguments; feedback; teacher clarification	Limited familiarity to structured discussion; participation is not yet evenly distributed; the process of understanding and synthesizing ideas takes time	Anggraeni et al. (2024); Pratama and Dewi (2022); Rifatunnisa et al. (2023); Yuniasih et al. (2024)
Create	Contextual problems or tasks; freedom to develop ideas; posters; mind maps; drawings; projects; digital products	Originality is not yet consistent; difficulty synthesizing simple concepts into digital ideas/products; the need for sufficient time	Anggraeni et al. (2024); Rifatunnisa et al. (2023); Suryana et al. (2021); Widyarti et al. (2024); Yuniasih et al. (2024)
Implementation context	Teachers as facilitators; supporting media/technology; group management; clear instructions; flexibility in implementation	Time and technology constraints; differences in student readiness; the initial need for stronger classroom management, especially in lower grades	Anggraeni et al. (2024); Pratama and Dewi (2022); Widyarti et al. (2024); Sarira et al. (2024)

Table 4 shows that the success of RADEC implementation is determined not only by the implementation of the five RADEC stages but also by the quality of the activities that take place at each stage. In the Read and Answer stages, reading materials and pre-learning questions serve to build students' prior knowledge and readiness before whole-class instruction. Digital tools such as E-LKPDs and e-modules can help structure these activities, but technology is not a mandatory component of RADEC. This is evident in the study by Pratama and Dewi (2022), where instruction had to be adapted because some students did not complete the initial activities due to forgetfulness, limited data allowances, or a lack of devices; five students even followed an alternative scheme because they did not have devices. These findings indicate that flexibility in implementation can be a strength of RADEC, but students' readiness in the early stages still influences the quality of subsequent stages.

In the Discuss and Explain phase, the primary support comes from group management, the assignment of roles, opportunities to present reasons, and teacher clarification. Anggraeni et al. (2024) show that the assignment of roles and responsibilities aids group activities, while the teacher continues to function as a facilitator, organizer, motivator, and provider of clarification. However, discussions do not automatically lead to HOTS. Yuniasih et al. (2024) show that the process of synthesizing concepts takes time and that not all students demonstrate the same level of conceptual development. Thus, the quality of questions, equitable participation, time management, and teacher support determine whether the Discuss-Explain approach truly becomes a space for arguing and evaluating ideas or merely an activity for sharing answers.

The Create stage reveals the clearest connection between opportunities for HOTS development and implementation challenges. Various studies have used posters, images, mind maps, props, simple models, videos, and digital products as forms of creative activities. Anggraeni et al. (2024), for example, facilitated students in producing drawings, fishbone diagrams for

disaster mitigation, environmental campaign videos, and digital posters. Nevertheless, producing a product does not in and of itself indicate a high level of creativity. Yuniasih et al. (2024) found that originality remains relatively weak and the process of synthesizing concepts takes time, while Widyarti et al. (2024) demonstrated that the development of creative thinking occurs gradually over several cycles. Therefore, the Create stage is best understood as a phase that provides space for knowledge transfer and idea development, but its success depends on prior knowledge, the scope of the task, time, and adequate teacher support.

Contextual conditions also influence the implementation of RADEC. Sarira et al. (2024), as the only study in the corpus involving third-grade students, explicitly reported that applying RADEC in lower grades requires stronger classroom management and the provision of implementation guidelines starting from the pre-learning stage. This finding is consistent with the concentration of research on fourth and fifth-grade classes identified in RQ1 and suggests that implementation with younger students likely requires greater procedural adjustments.

Based on this synthesis, the RADEC stages can be understood as an interconnected pedagogical sequence. Read-Answer builds prior knowledge, cognitive readiness, and independence; Discuss-Explain facilitates argumentation, evaluation of ideas, and conceptual clarification, while Create encourages the use of knowledge to generate ideas, solutions, or products. Weaknesses in the early stages have the potential to affect subsequent stages because students who lack adequate prior knowledge will have more limited material for argumentation during discussions and a weaker conceptual foundation for generating ideas in the Create stage. The relationships between these stages are summarized in Figure 4.

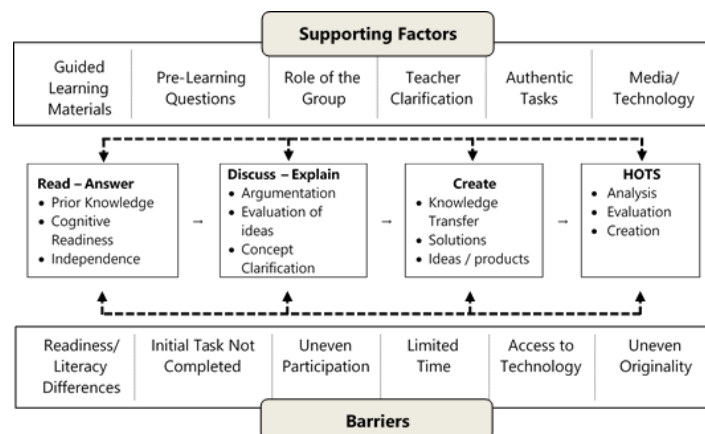


Figure 4. Synthesis of RADEC Implementation Factors in HOTS Development

Figure 4 shows that RADEC's potential to facilitate HOTS depends on the interconnection of cognitive functions across stages and the supporting factors surrounding them. Learning materials and pre-learning questions build readiness; group structure and teacher clarification support argumentation and evaluation, while authentic tasks provide space for knowledge transfer and creativity. Conversely, incomplete initial tasks, uneven participation, time and technological constraints, and underdeveloped originality can hinder this process. Thus, merely applying the syntax procedurally is insufficient if the activities at each stage do not yield the intended cognitive functions.

The heterogeneity of implementation forms also warrants attention. Most studies use the canonical Read-Answer-Discuss-Explain-Create syntax, but Afiah et al. (2025) replaced Explain with Evaluate, while Widodo et al. (2024) added a Project stage after Create. These variations indicate that interventions labeled RADEC in the corpus do not always exhibit identical syntactic fidelity. Therefore, the positive trend observed in RQ2 must be understood in conjunction with the quality and form of implementation in each study. In practice, teachers need to ensure that the Read material is appropriate for students' readiness levels, that the Answer questions require reasoning, that discussions provide opportunities for equal participation, that Explain leads to conceptual clarification, and that Create provides

sufficient openness for generating ideas or products.

CONCLUSION AND RECOMMENDATIONS

A Systematic Literature Review of 24 articles from 2021-2025 indicates that the research foundation for RADEC in the development of Higher-Order Thinking Skills (HOTS) among elementary school students remains concentrated within the Indonesian educational context. A total of 87.5% of the articles were published between 2023 and 2025, and 87.5% of the studies focused on students in grades IV-V, while grades I and II were not represented and grade III was represented by only one study. The research is also dominated by Natural Science and Natural and Social Sciences learning contexts, while critical thinking is the most frequently studied specific HOTS indicator. These findings indicate that the evidence base for RADEC-HOTS has expanded in recent years, but its empirical coverage remains uneven across grade levels, subject areas, and educational contexts.

In general, the available evidence generally indicates positive changes in HOTS or HOTS indicators following RADEC implementation, but the strength of these inferences varies depending on study design, comparison groups, outcomes, instruments, and implementation methods. Comparative evidence is relatively more consistent when RADEC is compared with conventional instruction or Direct Instruction. However, this advantage does not emerge uniformly when RADEC is compared with active learning models such as Problem-Based Learning (PBL); one study showed RADEC's advantage over PBL, while another found similar average achievements between the two models. This finding is one of the study's key results: while RADEC shows promising potential in supporting HOTS, its superiority over other active learning models cannot yet be universally asserted and must be understood within the context of the comparison and the nature of the research.

The implementation of RADEC also demonstrates that the five learning stages function as an interconnected sequence. Read-

Answer builds prior knowledge and cognitive readiness; Discuss-Explain facilitates argumentation, the evaluation of ideas, and the clarification of concepts, while Create provides space for the transfer of knowledge into ideas, solutions, or products. The Create stage also presents one of the implementation challenges because originality does not develop automatically and requires prior knowledge, time, sufficiently open-ended tasks, and proportionate teacher support. The success of RADEC is thus determined not only by the procedural implementation of its syntax but also by the quality of cognitive activities at each stage and the learning conditions that support them.

Generalizing these findings requires caution because all analyzed studies originated in Indonesia, were largely concentrated on grades IV-V and science instruction, and employed heterogeneous research designs and statistical reporting formats, making it impossible to estimate a combined effect. Future research should expand the testing of RADEC to grades I-III, non-science subjects, and educational contexts outside Indonesia, while employing stronger comparative designs and more consistent reporting of effect sizes. For practitioners, RADEC can be considered as an alternative to HOTS-oriented learning by ensuring pre-instructional readiness, equitable participation, time management, teacher facilitation, and authentic creative tasks.

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