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The Impact of RADEC Model on Scientific Literacy: Insights from Student Responses

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ABSTRACT

This descriptive study describes seventh-grade students' perceptions of the impact of the RADEC model on enhancing scientific literacy. Conducted at SMPN 54 Surabaya, the research involved 34 students from class VII G. A validated questionnaire using a Likert scale assessed students' responses, ranging from strongly disagree to strongly agree. Expert validators ensured the questionnaire's validity before data collection. Data collection was conducted using a survey method. Quantitative data analysis utilized descriptive statistics to reveal students' positive responses to the RADEC model, indicating its effectiveness in improving scientific literacy, particularly in understanding environmental pollution issues. The findings also highlight students' strong agreement on the benefits of the RADEC model, confirming its role in creating a conducive learning environment and enhancing comprehensive scientific literacy among students.

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1. Introduction

In the current era, where technology and science are rapidly evolving, scientific literacy has become an essential skill for individuals to function effectively in modern 21st-century society (Kristyowati & Purwanto, 2019). According to Zainuri et al. (2022) (2022), scientific literacy is a critical competency that every individual must possess to enhance their quality of life and to effectively engage with the advancements in science and technology. Consequently, it is imperative to cultivate scientific literacy among students from an early age to prepare them as the

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future generation. One strategy to achieve this is by designing educational experiences that foster the development of scientifically literate individuals. Mastery of scientific literacy enables students to keep pace with technological innovations, facilitates their understanding of other academic disciplines, and provides them with the foundation for pursuing productive careers (Blyznyuk, 2019; Fausan et al., 2021; T. R. Putri et al., 2022).

However, many studies have shown that scientific literacy among students is often inadequate. Global surveys such as PISA (Program for International Student Assessment) have highlighted the low comprehension and application of scientific concepts among students in various countries. According to data from the 2022 Program for International Student Assessment (PISA), the global average score for scientific literacy is 485, while Indonesia's average score is 383, placing it 67th out of 81 countries (OECD, 2023b). Although Indonesia improved its ranking from 71st in 2018 to 67th in 2022 according to OECD (2023b), its score decreased by 13 points from 2018 and remains 102 points below the global average (OECD, 2023a). These results indicate a decline in students' scientific literacy in 2022, which remains at a low level. This condition underscores the need for effective learning strategies to enhance students' scientific literacy.

Conventional learning approaches, dominated by lectures and passive absorption of subject matter, often fail to build a deep and relevant understanding of scientific concepts (Chudinova & Zaytseva, 2022; Samadi & Gheisari, 2021). In response, there has been a growing need for innovative learning models that promote active student engagement and the application of scientific concepts in real-world contexts. One such learning model that has gained attention is RADEC (Read, Answer, Discuss, Explain, Create). The RADEC model consists of five steps as per its name: Read, Answer, Discuss, Explain, and Create (Agustin et al., 2021; Pratama et al., 2019; Sopandi et al., 2019). This model adopts a holistic approach to science education, emphasizing a series of activities that include reading, questioning, discussing, exploring, and concluding scientific concepts. The RADEC model promotes deeper understanding through active interaction with the subject matter and provides opportunities for students to develop communication, collaboration, and critical thinking skills(Lestari et al., 2021; Sopandi, 2021; Sukardi et al., 2021).

The RADEC learning model is an instructional approach consisting of the following sequential steps: Read, Answer, Discuss, Explain, and Create. These steps form the basis of the RADEC model designation (Widyarti et al., 2024). The development of the RADEC model is grounded in Vygotsky's social constructivism theory (Sopandi, 2021), which posits that students can enhance their cognitive abilities through interactions with their social environment (Amahorseya & Mardliyah, 2023). In addition to being based on constructivist learning theory, this model's ease of recall and application by teachers is one of its advantages. This innovative learning model focuses on fostering students' skills in Higher Order Thinking Skills (HOTS), multiliteracy learning, and character education as 21st-century competencies (Sapitri et al., 2023). The RADEC model has several strengths and limitations (Sopandi, 2021). Its strengths include: 1) fostering students' reading interest, 2) enhancing reading comprehension skills, 3) improving students' preparedness for classroom or laboratory learning, 4) developing students' oral and

written communication skills, 5) training students' collaboration skills in groups, 6) increasing teachers' effectiveness in providing student assistance, 7) centering learning on students, 8) directing classroom learning towards activities that require social interaction for effective learning, 9) supporting the enhancement of multiliteracy (technology, subject areas such as science, communication, language, and culture), and 10) providing easily understandable instructional syntax or steps. However, its limitations include the need for the availability of reading materials as independent learning resources for students and its applicability only to students who possess basic reading skills, such as letter recognition, fluent word reading, understanding simple sentences, and interpreting the basic meaning of the text read.

Despite its promising potential, empirical research evaluating the impact of the RADEC model on students' scientific literacy through their responses remains limited. Some initial studies have shown positive results. For example, Putri & Zulfadewina (2023) demonstrated a significant improvement in scientific literacy through the application of the RADEC learning model. Research by Sukmawati & Zulherman, (2023) also showed an increase in students' scientific literacy after participating in lectures using the RADEC learning model. Additionally, Hasbi et al. (2023) found that the use of the RADEC learning model significantly impacts scientific literacy, but further research is needed to comprehensively understand the effectiveness of this model in enhancing students' understanding of science.

In the classroom learning process, two main parties are involved: teachers and students. Effective learning requires good interaction between the two. This interaction includes students' responses to the teaching methods applied by the teacher. These responses can be acceptance, rejection, or indifference to the material presented (Hrnčiříková & Hrbáčková, 2020). The formation of these responses is important as it can influence students' behavioral changes based on their experiences. Learning can be considered as an interaction between stimulus and response, with the stimulus as the input and the response as the output (Cox & Adams, 2021). In this study, the stimulus is the RADEC model, and the response is the students' reaction to the model, specifically in improving scientific literacy.

By investigating students' experiences and their responses to the RADEC model, this study aims to describe students' responses to the RADEC model in building scientific literacy. The findings of this study are expected to provide valuable guidance for educators and policymakers in designing effective learning strategies to enhance scientific literacy among students.

2. Method

This study employed a descriptive research method to thoroughly explore and analyze students' perceptions regarding the impact of the RADEC (Read, Answer, Discuss, Explain, Create) model on enhancing scientific literacy. The research was conducted at SMPN 54 Surabaya, a well-established secondary school, and involved a sample of 34 seventh-grade students, specifically from class VII G. The instrument used was a student response questionnaire, which had been validated by expert validators. This response questionnaire employed a Likert scale offering four response options: strongly disagree, disagree, agree, and strongly agree. The student response sheet consisted of 18 statements covering indicators of learning motivation, the stages of the RADEC model, scientific literacy skills, and the

suitability of the model with students' abilities. The data collection technique used in this study was a questionnaire directly distributed to the students. The data analysis technique employed in this study was quantitative descriptive analysis using percentages. Then the percentage of student responses is categorized as follows.

Table 1. Interpretation of Student Response Percentages

Percentage (%)	Description
0-20	80,1&
21-40	82,4%
41-60	90,4%
61-80	96,3%
81-100	86,0%

(Riduwan, 2018)

3. Results and Discussion

Results

The questionnaire responses were filled out by involving 34 students from class VII G. Students' responses to the RADEC model in enhancing scientific literacy were focused on aspects of learning motivation, RADEC model stages, scientific literacy skills, and the suitability of the model and presented described as follows.

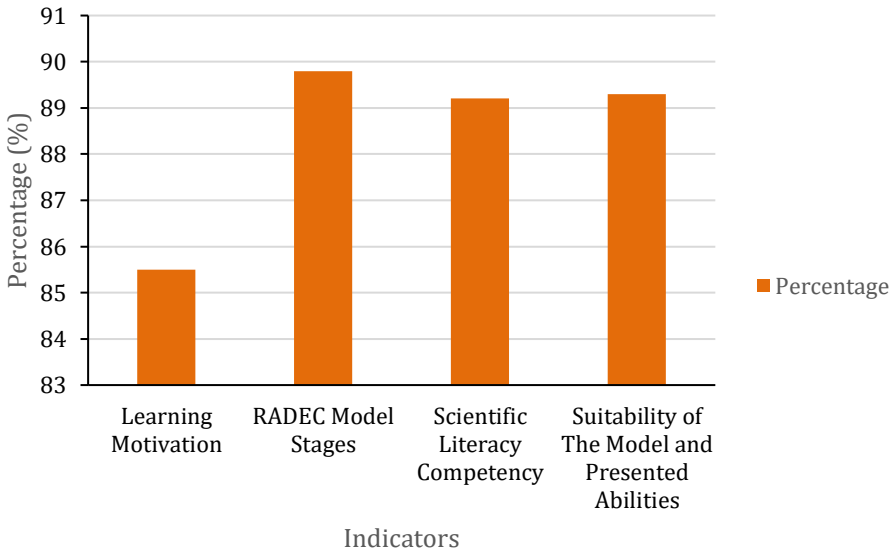

Figure 1. The Results of Students' Responses Questionnaire on the aspect of Learning Motivation

Based on Figure 1, it can be seen that the responses obtained from all statements answered by the students show the following percentages: for the learning motivation indicator, 85.5% of students responded with "strongly agree"; for the RADEC model stages indicator, 89.8% responded with "strongly agree"; for the scientific literacy skills indicator, 89.2% responded with "strongly agree"; and for the suitability of the model with abilities indicator, 89.3% of students responded with "strongly agree." Based on the analysis of student responses after the implementation of the RADEC model in science learning, it can be concluded that the overall student responses received a "strongly agree" rating with a percentage of 88.5%.

The results for each indicator are presented in Table 2, Table 3, Table 4, and Table 5 below.

Table 2. The Results of Students' Responses Questionnaire on the aspect of Learning Motivation

No.	Statements of the Questionnaire	Percentage
1.	The presented phenomena caught my attention and were able to enhance my motivation to study environmental pollution.	80,1&
2.	Learning with the RADEC model is not boring.	82,4%
3.	The applied learning can enhance cooperation among peers.	90,4%
4.	My active role in learning increases when the teacher implements this method.	96,3%
5.	I am not confused when environmental pollution materials are presented with the RADEC model.	86,0%
6.	The taught lessons make me understand and remember the learned material better.	77,9%

Based on Table 1, it can be inferred that students overwhelmingly agreed with the aspect of learning motivation, with an average percentage of 85.5%. This observation stems from the responses recorded in the questionnaire, where most students rated each statement with a score of 4 (strongly agree).

Table 3. The Results of Students' Responses Questionnaire on the aspect of RADEC Model Stages

No.	Statements of the Questionnaire	Percentage
1.	Reading activities provide me with better direction in the learning process.	88,2%
2.	The questions given in the worksheets help me in the learning process.	86,8%
3.	Peer discussions in the group help me understand the questions given.	91,2%
4.	The questions given in the worksheets help me to discuss with peers.	95,6%
5.	Group discussions motivate me to learn more.	90,4%
6.	Presentation activities make me confident to ask questions and provide suggestions.	86,8%
7.	Experimentation and product creation activities motivate me to learn.	89,7%

According to Table 2, it can be deduced that students overwhelmingly agreed with the stages of the RADEC model, with an average of 89.8%. This finding is based on the responses to each statement, where each statement received a strongly agreed response.

Table 4. The Results of Students' Responses Questionnaire on the aspect of Scientific Literacy Competency

No.	Statements of the Questionnaire	Percentage
1.	After this learning, my ability to explain phenomena scientifically has improved.	91,2%
2.	After this learning, my ability to design and evaluate scientific investigations has improved.	91,2%
3.	After this learning, my ability to interpret data and evidence scientifically has improved.	85,3%

Table 3's findings indicate that students predominantly expressed strong agreement regarding their science literacy skills, averaging at 89.2%. This observation is drawn from the percentages associated with each statement, where most statements fall into the strongly agree category.

Table 5. The Results of Students' Responses Questionnaire on the aspect of Suitability of

The Model and Presented Abilities

No.	Statements of the Questionnaire	Percentage
1.	Learning with the applied model makes me easily understand and proficient in scientific literacy to provide ideas or solve problems.	89,0%
2.	Observation, discussion, questioning, and presentation activities make me more enthusiastic in expressing opinions with peers in both the same group and different groups.	89,7%

Based on Table 4, it can be inferred that students overwhelmingly agreed with the aspect of suitability of model and presented abilities, with an average percentage of 89.3%. This observation stems from the responses recorded in the questionnaire, where most students rated each statement with a score of 4 (strongly agree).

Discussion

Based on Table 2, it is evident that students' responses regarding the aspect of learning motivation are overwhelmingly positive, with an average percentage of 85.5%. This indicates a strong agreement among students towards various statements related to their motivation in learning. For instance, in statement number 1, 80.1% of students expressed that the presented phenomena captured their attention and boosted their motivation to study environmental pollution. Furthermore, in statement number 2, 82.4% of students agreed that learning with the RADEC model was engaging and not boring. Additionally, in statement number 3, an impressive 90.4% of students believed that the applied learning method promoted cooperation among peers. Moreover, in statement number 4, an overwhelming majority of 96.3% of students stated that their active involvement in learning increased when the teacher implemented this method. In statement number 5, 86.0% of students indicated that they did not feel confused when environmental pollution materials were presented with the RADEC model. Lastly, in statement number 6, although slightly lower, 77.9% of students mentioned that the lessons taught using this method improved their understanding and retention of the material. These findings collectively suggest a strong positive correlation between the implementation of the RADEC model and students' motivation and engagement in learning about environmental pollution.

Table 3 presents the results of students' responses regarding the RADEC model stages. Overall, the responses indicate a high level of agreement among students towards various aspects of the RADEC model stages, with an average percentage of 89.4%. Specifically, in statement number 1, 88.2% of students expressed that reading activities provided them with better direction in the learning process. Similarly, in statement number 2, 86.8% of students mentioned that the questions given in the worksheets were helpful in their learning process. Additionally, in statement number 3, an impressive 91.2% of students believed that peer discussions in the group aided their understanding of the questions given. Moreover, in statement number 4, an overwhelming majority of 95.6% of students stated that the questions provided in the worksheets facilitated discussions with peers. In statement number 5, 90.4% of students indicated that group discussions motivated them to learn more. Furthermore, in statement number 6, 86.8% of students mentioned that presentation activities made them confident to ask

questions and provide suggestions. Lastly, in statement number 7, 89.7% of students expressed that experimentation and product creation activities motivated them to learn. These findings collectively suggest a strong positive correlation between the RADEC model stages and students' engagement and motivation in the learning process.

In analyzing the responses of students regarding their scientific literacy competency, Table 4 presents noteworthy findings. Firstly, in response to the statement addressing the improvement in their ability to explain phenomena scientifically after the learning process, an impressive 91.2% of students expressed agreement. This indicates a significant enhancement in their capacity to articulate scientific concepts effectively. Similarly, regarding the statement concerning the enhancement of their ability to design and evaluate scientific investigations following the learning experience, an identical percentage of 91.2% of students indicated agreement. This suggests a substantial improvement in their aptitude for conducting and assessing scientific inquiries. However, in response to the statement pertaining to the enhancement of their ability to interpret data and evidence scientifically, the percentage of students expressing agreement was slightly lower, at 85.3%. While still a majority, this indicates that there may be some areas where students feel less confident in their scientific literacy skills. Overall, Table 3's findings demonstrate that students predominantly expressed strong agreement regarding their science literacy competency, with an average percentage of 89.2%. This suggests an overall positive perception of their improvement in scientific literacy skills following the learning process.

Table 5 presents the findings of students' responses regarding the suitability of the model and the abilities presented. Firstly, in response to the statement regarding learning with the applied model enhancing their understanding and proficiency in scientific literacy to provide ideas or solve problems, an impressive 89.0% of students expressed agreement. This suggests that the applied model effectively facilitates their comprehension and competence in scientific literacy, enabling them to effectively contribute ideas and solve problems. Similarly, regarding the statement addressing how activities such as observation, discussion, questioning, and presentation fostered enthusiasm in expressing opinions with peers, both within the same group and across different groups, an even higher percentage of 89.7% of students indicated agreement. This indicates that these activities effectively engage students and encourage active participation and collaboration in expressing opinions and ideas with their peers. Overall, based on Table 4, it can be inferred that students overwhelmingly agreed with the suitability of the model and the presented abilities, with an average percentage of 89.3%. This suggests a positive perception among students regarding the effectiveness of the model and its ability to enhance their skills and engagement in scientific learning activities.

The research results indicate a high level of agreement among students regarding the effectiveness of the RADEC model in enhancing learning motivation, understanding of concepts, scientific literacy skills, as well as collaboration and communication abilities. Consistent with previous research showing that success in increasing learning motivation often occurs when students find the subject matter interesting and relevant to their daily lives (Ditta et al., 2020), students also expressed positive perceptions of the RADEC model. They acknowledged that the

structured approach of the RADEC model, which facilitates reading activities, peer discussions, and presentations, effectively deepens their understanding (Kusumaningpuri & Fauziati, 2021). Previous studies have also shown that the RADEC model can improve students' scientific literacy skills, including their ability to explain scientific phenomena, design and evaluate investigations, and interpret data (Nurpratiwi et al., 2023). Students also responded positively to the alignment of the RADEC model with their abilities, consistent with findings that the model effectively facilitates understanding of scientific concepts and enhances students' collaboration and communication skills (Sopandi, 2021).

4. Conclusions

The research findings suggest a positive response from students regarding the impact of the RADEC model in improving science literacy. Students predominantly expressed agreement on various aspects, including learning motivation, RADEC model stages, science literacy competencies, and the appropriateness of the model and skills presented with an average overall percentage of 88.5% with strongly agreed criteria. Overall, this study confirmed students' responses to the impact of the RADEC model in facilitating a conducive learning environment and promoting the development of comprehensive science literacy among students.

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