



## Development of Electronic Student Worksheets Based on the RADEC Learning Model to Improve Critical Thinking Skills of Students at the Indonesian School of Kuala Lumpur Malaysia

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### ABSTRACT

**Objective:** The Indonesian School of Kuala Lumpur is an educational institution established by the Indonesian Ministry of Education to facilitate learning for Indonesian students in Malaysia. This study aims to develop an electronic student worksheet (E-LKPD) to enhance students' critical thinking skills at the Indonesian School of Kuala Lumpur. The study adopts the RADEC learning model, as it is considered capable of fostering optimal collaboration aligned with 21st-century learning competencies.

**Method:** This study employs a Research and Development (R&D) approach using the ADDIE development model. Data on validity were obtained from three validators using validation sheets. Practicality was assessed by three observers using observation sheets. Effectiveness was evaluated using the SPSS One-Group Posttest-Only design and supported by student response questionnaires. Data analysis for validity and practicality was conducted based on the average scores provided by validators and observers. The effectiveness analysis involved normality testing and one-sample tests.

**Results:** The findings indicate an improvement in students' critical thinking skills, as demonstrated by the results of the one-sample test. This suggests that the E-LKPD based on the RADEC learning model is effective in enhancing critical thinking skills, particularly in science learning on the topic of vibrations and waves. Therefore, the developed teaching materials are recommended for use in science instruction, especially to improve students' critical thinking skills. **Novelty:** This study offers an innovation in instructional media through the development of E-LKPD integrated with the RADEC learning model to enhance the critical thinking skills of Indonesian students in Kuala Lumpur.

## INTRODUCTION

Twenty-first-century learning poses significant challenges in education, directly influencing how educational systems adapt to global shifts (Widarta et al., 2024). Students are increasingly required to navigate these global complexities by developing essential competencies, notably critical thinking skills (Minsih et al., 2024). The Indonesian School in Kuala Lumpur (SIKL), operating under the auspices of the Indonesian Ministry of Education, was established as a learning community to facilitate education for Indonesian children in Malaysia (Dwi et al., 2025). Interviews with educators at SIKL indicated that most junior high school students exhibit deficient problem-solving abilities, despite the integral connection between these skills and individual critical thinking (Apriyanti et al., 2024). Critical thinking encompasses the stages of formulation and evaluation, empowering students to resolve problems effectively through evidence-based solutions (Konoras et al., 2022).

One contributing factor to students' suboptimal critical thinking skills is the conventional selection of instructional materials (Yulianti et al., 2022). This is consistent with observations at SIKL, which indicated that a lack of diversity in teaching resources can adversely affect learning outcomes (Mahardhani et al., 2024). Consequently, there is a clear need for teacher professional development regarding the strategic selection of

materials for classroom activities (Fitri & Hidayati, 2024). SIKL has also adopted the Kurikulum Merdeka (Independent Curriculum), which prioritizes competency-based learning and skill development (Widiyanah et al., 2024). Notably, this curriculum framework is recognized for its robust capacity to enhance critical thinking skills (Lubis et al., 2023).

Enhancing critical thinking skills can be achieved through the strategic implementation of instructional materials, as their inherent components are instrumental in fostering student cognitive development (Widarta et al., 2024). Empirical evidence suggests that student worksheets (LKPD) play a pivotal role in augmenting these skills (Sumanik et al., 2023). However, the efficacy of LKPD is contingent upon its integration with a suitable pedagogical framework, specifically the "RADEC" (Read, Answer, Discuss, Explain, and Create) learning model. This model is reported to yield a more substantial positive impact when paired with LKPD compared to alternative instructional approaches (Widarta et al., 2024).

While the RADEC model has been extensively investigated regarding general student competencies, its integration into E-LKPD – specifically designed to address the deficit in problem-solving skills among students at Indonesian Schools in Kuala Lumpur (SIKL) – remains significantly under-researched. Previous studies have predominantly focused on conventional LKPD or domestic Indonesian school environments, resulting in a literature gap concerning digital-based tools that bridge the independent curriculum (Kurikulum Merdeka) with the unique characteristics of Indonesian students studying abroad. Amidst global educational shifts and technological advancements, reliance on printed LKPD is increasingly deemed inadequate (Zain et al., 2024). Consequently, E-LKPD emerges as a more effective medium for fostering problem-solving and digital literacy, offering the adaptability required to meet contemporary student needs (Sukmawati & Ghofur, 2023).

Furthermore, the RADEC framework is recognized for its capacity to maximize collaborative learning within the context of 21st-century educational criteria (Suriani & Yanti, 2024). In science education, this approach is particularly pertinent as it encompasses experimentation, observation, and scientific reasoning (Andriyani et al., 2024). The model is structured into five distinct pedagogical stages: Reading, Answering, Discussing, Explaining, and Creating (Febrianti et al., 2024). Through these stages, RADEC is reported to cultivate diligent reading habits, deepen conceptual understanding, and bolster student motivation to develop individual competencies (Rizal et al., 2024).

Based on the analysis of the fundamental issues underlying low critical thinking skills, this research develops an E-LKPD grounded in the RADEC instructional model, specifically tailored for science education (Tsuroyya et al., 2022). The novelty of this study lies in the integration of the RADEC model with the enhancement of digital literacy and scientific reasoning, uniquely adapted to the context of Indonesian overseas schools. This innovation transcends mere digitization; it reconstructs the RADEC syntax – Read, Answer, Discuss, Explain, and Create – into an interactive medium designed to facilitate autonomous learning. By focusing on the augmentation of students' critical thinking skills, this model represents a strategic effort to provide SIKL educators with innovative pedagogical tools that are highly relevant to the specific characteristics and needs of Indonesian students abroad (Bestira et al., 2024).

## **RESEARCH METHOD**

This research was conducted in Kuala Lumpur, Malaysia, and piloted with junior high school students at the Indonesian School of Kuala Lumpur. The study took place during the odd semester of the 2025/2026 academic year. The trial population for the development of the E-LKPD consisted of 30 eighth-grade students at SIKL in the 2025/2026 academic year who studied vibration and wave materials.

### 1) Main Research Data

#### a) Questionnaire

The instruments used consisted of two types of questionnaires: a validation sheet to measure the validity of the E-LKPD and an implementation sheet to assess practicality and identify research constraints.

#### b) Test

The test method employed a one-group posttest-only design, in which students were given treatment followed by a posttest to determine the effectiveness of the developed E-LKPD.

### 2) Supporting Research Data

#### a) Interview

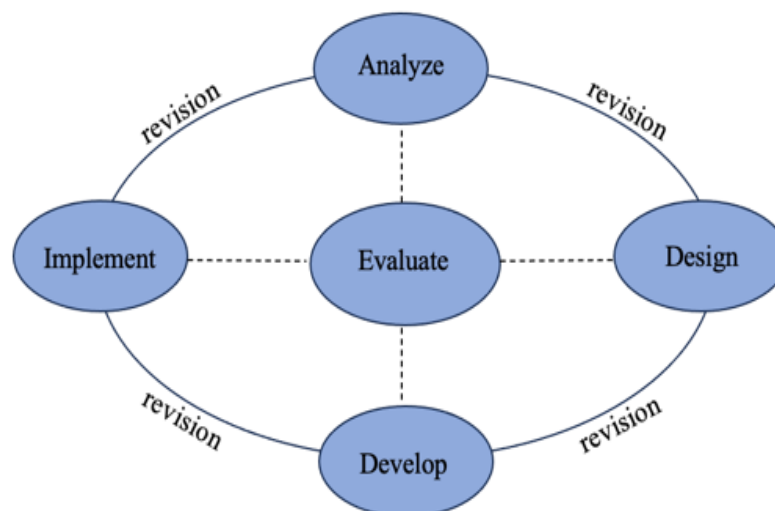
Interviews were conducted to obtain information related to the research topic as a basis for developing the E-LKPD based on the RADEC learning model.

#### b) Observation

The researcher conducted direct observations of the learning process, accompanied by an observer, to obtain data on the implementation.

#### c) Documentation

Photos and videos were taken during the activities to support the completeness of the research data.



**Figure 1.** ADDIE development model stages (Branch, 2009).

This study employed a research and development (R&D) method using the ADDIE development model. The five stages of the model are illustrated in the following Figure 1. (1) Analysis, this stage involves analyzing students' problems, characteristics, and learning needs; (2) Design, this stage focuses on developing an initial draft of the teaching materials in the form of an electronic worksheet (E-LKPD) based on the RADEC learning model, aligned with critical thinking skill indicators; (3) Development, this stage involves compiling the electronic worksheet based on predetermined components, followed by validation by three experts to determine the validity of the product; (4) Implementation,

in this stage, the finalized product is implemented in the learning process in accordance with the lesson plan; (5) Evaluation, this stage evaluates the learning outcomes and includes a formative evaluation in the form of a student response questionnaire.

The data analysis methods included validity, practicality, and effectiveness tests. The following analysis procedures were applied;

- a. The validity test was conducted using quantitative descriptive analysis by expert validators. The validity percentage of the E-LKPD based on the RADEC learning model was calculated using the following formula;

$$\text{validity (\%)} = \frac{\text{total score obtained}}{\text{maximum total score}} \times 100\%$$

**Table 1.** Criteria and Levels of Validity (Hulu & Dwiningsih, 2021).

No	Value criteria(%)	Level of validity
1	>81	Very Valid
2	61-80	Valid
3	41-60	Quite Valid
4	21-40	Less Valid
5	< 20	Not Valid

The E-LKPD based on the RADEC learning model is considered valid if it achieves at least a “valid” category, with a score ranging from 61% to 80%.

- b. Practicality was measured based on the results of observations of the implementation process and the obstacles encountered during learning using the E-LKPD based on the RADEC learning model. The level of practicality of the E-LKPD was calculated using the following formula;

$$\text{Practical (\%)} = \frac{\text{Total score obtained}}{\text{maximum total score}} \times 100$$

**Table 2.** Criteria and Levels of Practicality (Nesri & Kristanto, 2020).

No	Value criteria (%)	Level of practicality
1	>81	Very Practical
2	61-80	Practical
3	41-60	Quite Practical
4	21-40	Not Practical
5	< 20	Not Practical

The E-LKPD based on the RADEC learning model is considered practical if it achieves at least a “practical” category, with a score ranging from 61% to 80%.

- c. The effectiveness of the E-LKPD was determined based on students’ posttest scores.
  - 1) The posttest data were analyzed using a one-sample t-test.

**Table 3.** One-Group Posttest-Only Experimental Design

Class	Treatment	Postest
8	O	O <sub>2</sub>

a) Normality test

The normality test was conducted to determine whether the data were normally distributed using the Shapiro–Wilk and Kolmogorov–Smirnov tests. The decision criteria were as follows: if the significance value (p-value) was greater than 0.05, the data were considered normally distributed; however, if the p-value was less than or equal to 0.05, the data were considered not normally distributed.

b) One-Sample t-test.

If the data were normally distributed, a one-sample t-test was performed. The decision criteria were as follows:

- 1) If the significance value (p-value) was  $\geq 0.05$ , the null hypothesis ( $H_0$ ) was accepted and the alternative hypothesis ( $H_a$ ) was rejected.
- 2) If the p-value was  $< 0.05$ , the null hypothesis ( $H_0$ ) was rejected and the alternative hypothesis ( $H_a$ ) was accepted.

$H_0$  The RADEC learning model has no significant effect on students' critical thinking skills.

$H_a$  The RADEC learning model has a significant effect on students' critical thinking skills.

2) Student Response Analysis

Student responses were obtained through a questionnaire administered at the end of the lesson. The responses were then analyzed using the following formula;

$$RS = \frac{\text{Data collection results score}}{\text{maximum total score}} \times 100\%$$

**Table 4.** Criteria and Categories of Student Responses (Khairiyah, 2018).

No	Score	Criteria
1	RS < 50%	Not good
2	50% ≤ RS < 70%	Deficient
3	70 %≤ RS < 85%	Good
4	85 %≤ RS≤ 100%	Very good

The E-LKPD is considered effective if the one-sample t-test results in the rejection of the null hypothesis ( $H_0$ ) and the acceptance of the alternative hypothesis ( $H_a$ ), which is further supported by student responses categorized as at least “good.”

## RESULTS AND DISCUSSION

### RESULT

The development of the E-LKPD based on the RADEC learning model to improve students' critical thinking skills was conducted using the ADDIE development model, which consists of the stages of analysis, design, development, implementation, and evaluation. The implementation of each ADDIE stage in this study is described as follows.

### ***Analysis***

This stage involved a performance analysis, including interviews with eighth-grade science teachers. The science learning process was conducted face-to-face, with a duration of 25 minutes per lesson. The teaching materials used were limited to textbooks, and no electronic-based teaching materials were available. Furthermore, an analysis of students' competencies and characteristics was conducted through interviews with teachers to identify their prior knowledge and abilities related to critical thinking skills. In addition, a curriculum and learning objectives analysis was carried out to determine the current curriculum and to align the learning objectives with the expected learning outcomes for the material to be taught.

### ***Planning***

In this stage, the researcher designed the E-LKPD product based on the RADEC learning model using the Canva application. The components of the E-LKPD included a foreword, table of contents, user guide, introduction, concept map, and RADEC-based learning activities. It also incorporated critical thinking skill indicators, learning outcomes, and learning objectives. After the product was completed, it was converted into an electronic format using the Heyzine platform

### ***Development***

This stage involved validation by three expert validators, consisting of lecturers from the Bachelor of Science Education program at the University of Jember. The validation process employed an evaluation instrument in the form of a validation sheet based on three assessment aspects: technical, construction, and didactic aspects. The validation data were then analyzed and interpreted based on the level of validity (Table 5).

**Table 5.** E-LKPD Validation Results

Assessment Aspects	Assessment percentage%			Average %	Category
	Validator 1	Validator 2	Validator 3		
Technical Aspects	85	80	90	85	very valid
Construction Aspects	88	80	92	87	very valid
Didactic Aspects	73	84	87	81	very valid
Average %	<b>82</b>	<b>81</b>	<b>90</b>	<b>84</b>	very valid

Table 5 shows that the average validation score from the three validators was 84%, which is categorized as "very valid." This indicates that the developed E-LKPD is suitable for use in the learning process. Several suggestions provided by the validators were incorporated into the revisions.

### ***Implementation***

This stage was conducted by the researchers to test the product and measure the practicality of the E-LKPD (Figure 2). The trial was carried out at the Indonesian School in Kuala Lumpur, Malaysia, involving 30 eighth-grade junior high school students as participants. The learning activities were conducted face-to-face over two meetings, with a total duration of 4 instructional periods (4 × 25 minutes). During the implementation,

observers monitored the learning process to collect practicality data. They observed the activities and completed observation sheets based on predetermined aspects. The results of the practicality data analysis are presented in Table 6.

a. Before revision

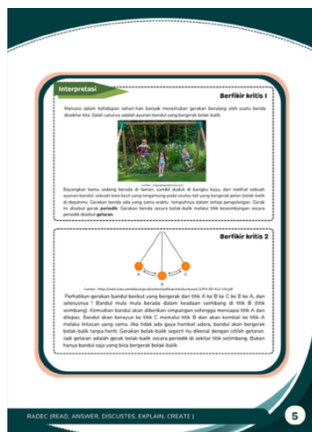


(The cover does not include the terms “critical thinking skills” and “barcode.”)

b. After revision



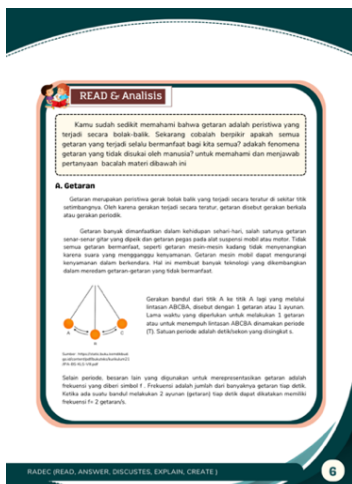
(The cover now includes the terms “critical thinking skills” and “barcode.”)



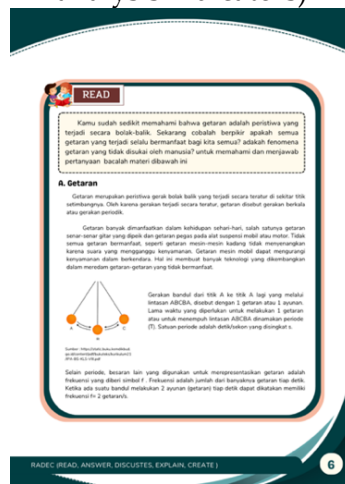
(Before revision, the interpretation indicators were combined with the analysis indicators)



(After revision, the interpretation indicators were combined with the analysis indicators)



(Before revision, the analysis indicators were not separated from the READ stage)



(After revision, the analysis indicators were separated from the READ stage)

Figure 2. Results before and after revision based on validator feedback.

**Table 6.** Results of Practicality Analysis

Meeting number -		Percentage (%)	Category
1	2		
92	92	92	Very practical
83	92	88	Very practical
92	92	92	Very practical
92	75	83	Very practical
92	100	96	Very practical
83	83	79	Practical
92	100	96	Very practical
92	92	92	Very practical
<b>90</b>	<b>91</b>	<b>90</b>	<b>Very practical</b>

Table 6 shows the average percentage across the two meetings, as observed by three observers, with a score of 90%, which falls into the “very practical” category. Based on these findings, it can be concluded that the implementation of the learning process was categorized as very practical. Practicality refers to the level of ease in using teaching materials during the learning process, including aspects such as language clarity and presentation (Satinem et al., 2024). However, several obstacles were encountered during the learning process, particularly related to students’ attitudes and responses, such as a lack of focus and failure to follow the given instructions. The identified obstacles and their corresponding solutions are presented in Table 7.

**Table 7.** Obstacles and Solutions in the Learning Process

Constraints	Solutions
Students did not understand the initial material in the interpretation and analysis sections.	The teacher provided guidance and re-explained the material using simple and clear language, along with examples from students’ daily activities to facilitate understanding.
Students had difficulty completing simple experiments presented in the vibration video.	The teacher provided additional clear illustrations to help students better understand the concepts.
Students had difficulty conducting simple experiments using a Slinky.	The teacher demonstrated the experiment using a Slinky and related the observed phenomena to students’ everyday experiences.

### **Evaluation**

This stage presents the results of the learning process, as measured by the effectiveness of the developed product. The effectiveness was evaluated based on students’ critical thinking skills and their responses to the questionnaire. The critical thinking skill scores were analyzed using normality tests and a one-sample t-test. The results of the critical thinking skills assessment are presented as follows;

**Table 8.** Results of the Normality Test

	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Posttest	.124	30	.200*	.963	30	.362

Based on Table 8, the posttest data were found to be normally distributed. The normality test results showed a significance value of 0.362 in the Shapiro-Wilk test and 0.200 in the Kolmogorov-Smirnov test. Since both p-values were greater than 0.05, the data were considered normally distributed. As the assumption of normality was met, hypothesis testing was conducted using a one-sample t-test. The results of the hypothesis test obtained from SPSS are presented as follows;

**Table 9.** Results of the One-Sample t-Test

Test Value = 75								
	t	df	Significance		Mean Difference	95% Confidence Interval of the Difference		
			One-Sided	Two-Sided		Lower	Upper	
			p	p				
Posttest	3.239	29	.002	.003	5.767	2.13	9.41	

The results of the hypothesis test indicate that the significance values were 0.002 (< 0.05) for the one-tailed test and 0.003 (< 0.05) for the two-tailed test. Therefore, the null hypothesis ( $H_0$ ) was rejected, and the alternative hypothesis ( $H_a$ ) was accepted, indicating that the RADEC learning model has a significant effect on students' critical thinking skills. These findings suggest that the implemented learning process contributed to the improvement of students' critical thinking skills. The analysis of critical thinking skill scores for each indicator is presented in Table 10.

**Table 10.** Results of Students' Critical Thinking Skills

Critical thinking skills indicators	Average value (%)	Category
Interpretation	80	High
Analysis	82	High
Interference	89	High
Evaluation	79	High
Explanation	71	High Enough
Self-Regulation	83	High
Average	<b>81</b>	High

Based on Table 10, the learning outcomes related to critical thinking skills show that five indicators were categorized as high, while one indicator was categorized as moderately high. The lowest average score was found in the explanation indicator, with an average of 71%, which falls into the moderately high category. In contrast, the highest average score was obtained in the inference indicator, with a score of 81%, categorized as high. Overall, the average score across the six critical thinking skill indicators was 81%, which is classified as high. These results indicate that the effectiveness of the RADEC-based E-LKPD in enhancing students' critical thinking skills can be considered high, as the average scores for each indicator fall within the high category.

The effectiveness of the RADEC-based E-LKPD is further supported by the analysis of student response questionnaires. The questionnaires were administered to evaluate students' responses to the implementation of the RADEC-based E-LKPD at the Indonesian School in Kuala Lumpur. The results of the student response analysis are presented in Table 11.

**Table 11.** Results of Student Response Analysis

Assessment Aspects	Percentage (%)	Category
Student Interest and Ease of Use of the E-LKPD	90	Very good
Appropriateness of Materials in the E-LKPD	88	Very good
Clarity and Comprehensibility of the Language Used	89	Very good
Average	89	<b>Very good</b>

Based on Table 11, the results of the student response analysis indicate that the interest aspect achieved a percentage of 90%, categorized as “very good.” The material aspect obtained a score of 88%, also in the “very good” category, while the language aspect reached 89%, similarly categorized as “very good.” Overall, the average score across the three assessment aspects was 89%, which falls into the “very good” category. Furthermore, both the one-sample t-test results and the student response analysis met the established criteria. The one-sample t-test results indicated that the RADEC learning model was effective in improving students’ critical thinking skills, while the student responses demonstrated a very positive perception of the implemented learning model. Taken together, these findings confirm that the RADEC learning model is effective in enhancing students’ critical thinking skills.

## **DISCUSSION**

### ***Validity of the RADEC-Based E-LKPD***

The validation of the RADEC-based E-LKPD was conducted by three expert validators using a validation sheet. The results showed an average validation score of 84%, which is categorized as “very valid.” This indicates that the developed product is suitable for use in the learning process. This finding is consistent with previous studies stating that a product can be considered valid when it meets all assessment criteria based on the overall evaluation of validators and is therefore appropriate for implementation (Tukan et al., 2020; Supriyaddin et al., 2024). Furthermore, a product is deemed feasible for use when the percentage of assessment results falls within the valid category according to predetermined criteria (Mustafa et al., 2023).

### ***Practicality of the RADEC-Based E-LKPD***

The practicality of the RADEC-based E-LKPD was tested through its implementation at the Indonesian School of Kuala Lumpur (SIKL) with eighth-grade students over two meetings. Practicality data were obtained from observations conducted by three observers using a learning implementation sheet at each meeting. The results indicated a practicality score of 86%, which falls into the “very practical” category. This high level of practicality reflects that the learning activities were carried out in accordance with the lesson plan and were consistent with the stages of the RADEC learning model (Anjarwati & Purnomo, 2025). These findings suggest that the use of experimental-based learning activities provides meaningful learning experiences and contributes to the development of students’ thinking skills (Sudiana et al., 2025).

### ***Effectiveness of the RADEC-Based E-LKPD***

The effectiveness of the RADEC-based E-LKPD on vibration and wave material was evaluated based on students’ critical thinking skills and their responses to the learning process. The results of the critical thinking skills test, analyzed using a one-sample t-test

in SPSS with a minimum mastery criterion (KKM) of 75, showed significance values of 0.002 ( $< 0.05$ ) for the one-tailed test and 0.003 ( $< 0.05$ ) for the two-tailed test. These results indicate that the null hypothesis ( $H_0$ ) was rejected and the alternative hypothesis ( $H_a$ ) was accepted, meaning that the RADEC learning model has a significant effect on students' critical thinking skills. Furthermore, the findings demonstrate that students experienced a significant improvement in their critical thinking skills after using the RADEC-based E-LKPD. This is supported by previous studies stating that effectiveness can be observed through the learning process during the use of teaching materials (Idayanti et al., 2024) and that learning is considered effective when it is implemented in accordance with the planned instructional design (Pratama, 2024). In addition, the results of the student response questionnaire showed an average score of 89%, which falls into the "very good" category. This indicates that students responded positively to the use of the RADEC-based E-LKPD and that the product is appropriate for use in learning. Positive learning experiences are known to enhance students' interest, engagement, and learning outcomes (Savitri et al., 2016). Overall, the results of the statistical analysis and student response data confirm that the RADEC-based E-LKPD is effective in improving students' critical thinking skills.

## CONCLUSION

**Fundamental Findings:** The findings indicate that the RADEC-based E-LKPD contributes positively to students' critical thinking skills and demonstrates "very good" criteria in terms of validity, practicality, and effectiveness. **Implications:** The implementation of the RADEC-based E-LKPD shows a significant improvement in students' critical thinking skills, highlighting its potential as an effective instructional tool in supporting 21st-century learning. **Limitations:** This study was limited by the implementation of a restricted number of experimental sessions due to reduced instructional time, which resulted from a temporary change in the learning location. This condition affected the overall duration of the learning process. **Future Research:** There is still limited research on the RADEC learning model, particularly in relation to 21st-century skills. Therefore, future studies are recommended to further explore and expand the application of the RADEC model, including the integration of traditional learning materials into digital formats and their combination with innovative learning models to enhance learning outcomes.

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