



Effectiveness of the Reading, Answering, Discussing, Explaining, and Creating (RADEC) Learning Model in Improving High School Students' Critical Thinking Skills on Colloid Material

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Article Info

Article history:

Received: 11-06-2024

Revised: 08-08-2024

Accepted: 18-08-2024

Available online: 31-08-2024

Keyword:

Effectiveness; RADEC Learning Model; Critical Thinking Skills

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Abstract

Students need to be able to think critically in order to meet the challenges of the 21st century. Be that as it may, the decisive reasoning abilities of undergraduates are still somewhat low. The RADEC model is a learning model that can aid in the development of critical thinking abilities. The goal of this study is to find out how well the RADEC model helps students in high school think critically about colloidal materials. This study employs experimental, quantitative research techniques. The population is all undergraduates in class XI MIPA at SMAN 5 Samarinda. The examples were undergraduates from class XI MIPA 2 and XI MIPA 4 at SMAN 5 Samarinda, adding up to 75 individuals. The exploration test was chosen utilizing a group irregular inspecting strategy. One-group pre-test post-test design was utilized in the research design. Information assortment involves tests as pre-tests and post-tests, educator and understudy movement perception sheets, and understudy reaction surveys. Statistical tests were conducted first, including the N-Gain test and the effect size test, for data analysis. According to the findings of the research, the RADEC model meets the effective criteria in terms of students' responses to learning based on the RADEC learning model and their increased critical thinking abilities. The findings of the research lead us to the conclusion that the RADEC model works to improve students' critical thinking abilities.

How to Cite: Fatimah, N. H., Usman., & Sukemi. (2024). Effectiveness of the Reading, Answering, Discussing, Explaining, and Creating (RADEC) Learning Model in Improving High School Students' Critical Thinking Skills on Colloid Material. *Jambura Journal of Educational Chemistry*, 6(2), 86-93. <https://doi.org/10.37905/ijec.v6i2.25989>

1. INTRODUCTION

According to Susanti et al (2018) and Wijayanti et al (2020), Critical thinking is the ability to think rationally in making decisions and is one of the 21st-century skills that students need to have and master to be able to determine the concepts used in solving problems, formulate an action, and be able to evaluate the decisions taken in solving problems. According to Prameswari et al (2018) and Kusumaningtyas et al (2020), critical thinking is thinking that uses reason to solve a problem by first understanding the problem so that you know the causes and consequences. After that, put forward solutions to solve the problem clearly and draw conclusions from the existing problems.

Students should have critical thinking because it can help them to solve problems encountered while studying, such as when doing assignments and exam questions. However, Indonesian students' critical thinking abilities remain relatively low. This is supported by the Program for International Student Assessment (PISA) survey results, which demonstrate that Indonesian students are still relatively inept at solving problems that require critical thinking skills (Agnafia, 2019). In this manner, decisive reasoning abilities should be thought of and arrangements looked for so that undergraduates' decisive abilities to reason increment.

It is not expected that students at school have a low level of critical thinking skills. In order for students to actively participate in the learning process, they should be

able to think critically and have a good understanding of questions, gathering relevant information, thinking creatively, presenting logical arguments as well as making conclusions (Agustiana, 2019; Manik et al., 2020). This is in line with of implementation of the 2013 curriculum, where students should become more engaged and not just concentrate on a teacher during their learning process so that they can develop critical thinking skills (Redhana, 2019).

It demonstrates that the learning process in schools currently does not yet implement a learning model that can assist students in training and developing critical thinking skills, based on interviews and direct observations conducted with chemistry teachers at SMAN 5 Samarinda. Students become passive, unable to master 21st century skills optimally, have a low desire to ask questions about material they do not understand, and have a low interest in reading as a result of teachers still employing the direct instruction learning model. Understudies will generally just acknowledge the learning material introduced by the educator without needing to study and investigate all the more profoundly and persistently.

Because the students' pre-test results were still relatively low on colloidal material, the classroom learning process needs innovations like the application of learning models so that students' critical thinking skills can grow and improve in theoretical material like colloidal material. The Read, Answer, Discuss, Explain, and Create (RADEC) learning model can be used to improve students' critical thinking abilities regarding colloidal materials. RADEC learning method that can assist students in acquiring competencies and skills relevant to the 21st century, one of which is the capacity to think critically.

There are several advantages to the RADEC of learning, including that it enables students to optimally use their thinking skills to be able to learn material independently, collaboratively develop communication abilities, and improve reading habits so that they play an active role during education (Sopandi, 2019; Agustin et al., 2021). It has been proven in research Andini & Fitria (2021) and Yulianti et al (2022) that the RADEC learning model which requires students to be active in class at several stages of their education can improve critical thinking skills. The RADEC learning methodology has been extensively utilized in chemistry education, educational material development, and research. However, no research on the efficacy of RADEC learning models for enhancing high

school students' critical thinking abilities regarding colloidal material has been conducted or reported.

2. METHOD

This study is quantitative examination utilizes exploratory strategies. The research design is a one-group pre-test-post-test design in which both classes receive the same treatment without a comparison class. The research model is a pre-experimental design (Afifah & Hartatik, 2019). To see more clearly the research design is presented in Table 1.

Table 1. *One-group pre-test post-test design*

Pre-test	Treatment	Post-test
O ₁	X	O ₂

(Sriyanti et al., 2020)

All students in the class XI MIPA at SMAN 5 Samarinda participated in this study, research sample comprising of those enrolled in classes XI MIPA 2 and XI MIPA 4. Cluster random sampling was used to select the sample. The sample was chosen randomly by the researcher because all classes had the same abilities. The same treatment including the use of the RADEC, has been implementation to the research sample. Test techniques consisting of pretesting and posttest methods shall be used in data collection. Before the execution of the RADEC, a test has been led to decide the degree of understudies' decisive reasoning abilities. A post-test has been administered to assess students' critical thinking abilities following the RADEC implementation.

The data processing and analysis technique used is the normality test using the Shapiro Wilk test which is processed with SPSS for Windows on pre-test and post-test data as a first step before carrying out the paired t test (difference test) (Setianingsih & Nelmiawati, 2020). Next, a homogeneity of diversity test was carried out using the Levene test which was processed using SPSS for windows (Koroh & Ly, 2020). Then, using the SPSS for Windows application, conduct the t-test with a significance level of less than 5% to determine whether or not the differences in students' critical thinking skills are significant (Kartini et al., 2020). On the off chance that the consequences of the t test show that there is a distinction in understudies' decisive reasoning abilities when executing the RADEC, then, at that point, the N-Gain test is kept on deciding the extent of the

expansion in understudies' decisive reasoning abilities when being dealt with utilizing the RADEC and went on with the impact size test for viability of the RADEC in further developing understudies' decisive reasoning abilities.

3. RESULT AND DISCUSSION

3.1. Result

Data on critical thinking skills of students in class XI MIPA 2 and averages value are presented in Figure 1.

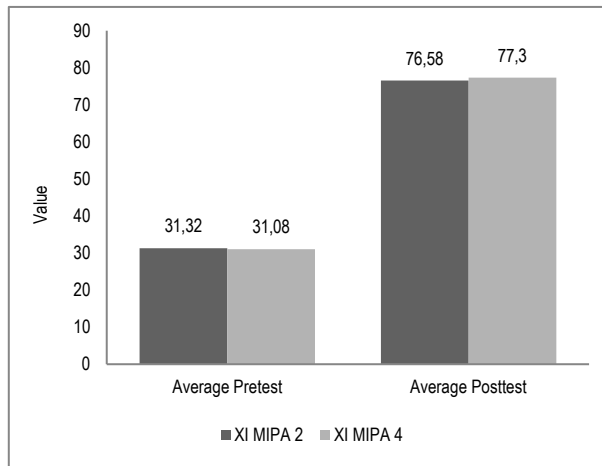


Figure 1. Average *pre-test* and *post-test*

Additionally, paired samples were tested to see if there was a significant difference in the improvement in students' critical thinking skills prior to and following the implementation of RADEC, where normalization and homogeneity tests had previously been performed. The t-test results can be seen in Table 2.

Table 2. Paired sample t-test

Class	Test		
	N	df	Sig. (2-tailed)
XI MIPA 2	38	37	0,000
XI MIPA 4	37	36	0,000

According to Table 2, a sig value of less than 0.05 indicates that there is a significant difference between the pre- and post-test scores of students prior to and following the implementation of the RADEC. Then, the pre-test and post-test scores of class XI MIPA 2 and XI MIPA 4 understudies were dissected utilizing the N-Gain test and afterward the impact size test as introduced in Figure 2.

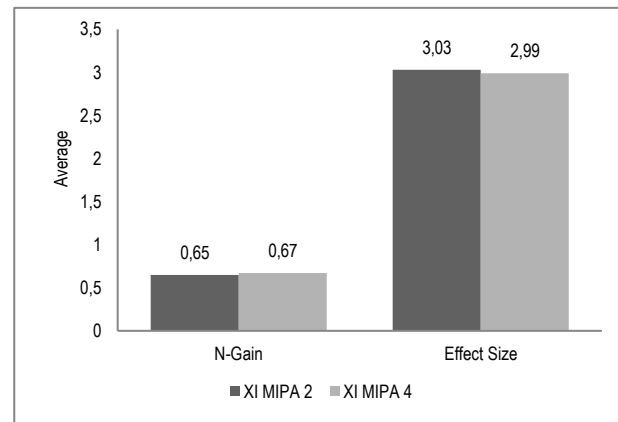


Figure 2. Averages N-gain and effect size

Figure 2 depicts the N-Gain of critical thinking skills for class XI MIPA 2 students, who scored 0.65, placing them in the medium category, and for class XI MIPA 4 students, who scored 0.67, also placing them in the medium category. On the basis of N.Gain's value for critical thinking skills per class, an average of 0.66 was obtained, which falls into the medium category. It demonstrates that the RADEC of learning is successfully utilized to enhance students' capacity for critical thinking. A learning model is considered effective if its value N-Gain falls within the minimum medium range.

Class XI MIPA 2 has an effect size of 3.03, which includes a large category, while Class XI MIPA 4 has an effect size of 2.89, which also includes a large category. On the basis of the effect size value, an average of 3.01 has been obtained for each class, including the large category. It demonstrates that students' critical thinking abilities are significantly enhanced by the RADEC of learning.

The marks of decisive reasoning abilities in this study are giving straightforward clarifications, making ends, building essential abilities, giving further clarifications, and creating procedures and strategies (Ardiyanti & Nuroso, 2021). Because students' abilities in these five indicators were low, the researcher chose them because the researcher wanted to improve students' critical thinking skills by developing these indicators. N-Gain test was likewise done for every sign of Decisive Reasoning Abilities. The point is to decide the N-Gain esteem classification. Table 3 shows the gain values for

each critical thinking skill for class XI MIPA 2 and XI MIPA 4.

Table 3. N-Gain Value on Critical Thinking Skills Indicator

Indicator	Class XI MIPA 2	Category	Class XI MIPA 4	Category
Provide a Simple Explanation	0,81	High	0,86	High
Building Basic Skills	0,62	Medium	0,59	Medium
Making Conclusions	0,55	Medium	0,52	Medium
Provide Further Explanation	0,61	Medium	0,73	Medium
Building strategy and tactics	0,70	Medium	0,60	Medium

3.2. Discussion

In the High category, according to Table 3, students' assessment of their ability to think critically and provide simple explanations are taken into account. This is in line with research by Arung et al (2022) According to this report, students at SMAN 5 Samarinda are able to master indicators of critical thinking skills in the field of chemistry, such as indicators of simple explanations in the upper category. The indicator of providing a simple explanation is an indicator that requires students to learn to focus on the question and then analyze the question well, so that they are able to provide a very precise explanation of the available questions. Based on Table 3, it means that students have focused on the question and have analyzed the question well so that they are able to analyze the concept of the difference between solutions, colloids and suspensions and are able to analyze the cause of colloids being able to dissolve water and fat correctly. This shows that, as a result of the success of their learning process, students' critical thinking skills are improving.

The indicator provides a simple explanation included in the high category, meaning that students' critical thinking skills in this indicator are very good. This is because students have been trained to dig up information from various sources, both from books or the internet through the reading stage in the RADEC learning model. The reading stage is carried out by students

independently outside the classroom. At this stage, students are given pre-learning questions to be more focused in digging up information. This is based on the idea that some information can be mastered by students themselves without the help of others (Pratama et al., 2019). By giving students independent reading assignments before studying in class, it will train students to analyze questions and answer questions about an explanation or statement by making simple explanations. Thus, learning in class is more focused on parts of the subject matter that are considered difficult and have not been mastered by all students (Aryani et al., 2022).

As part of their education, students will learn how to analyze a question on the student worksheet LKPD reading and answering stages. In order to respond to questions from the LKPD, students are instructed during this phase to investigate and gather as much information as they can from a variety of learning resources. This way, students will learn how to independently comprehend a material concept and develop their critical thinking skills for straightforward explanations. This is consistent with the assertion that Pratama et al (2019) where it is stated that students can independently acquire certain knowledge and concepts without the assistance of others.

The data investigated and gathered by understudies alludes to the LKPD that has been given by the educator, the point is that the data looked for by understudies is more engaged and as per learning goals. Through these stages, students will be trained to focus and analyze questions well so that they find the right answers and concepts based on the questions found on the LKPD. Students' ability to independently analyze and develop concepts can be enhanced by incorporating LKPD into the learning process. As according to Arung et al (2022), In the RADEC learning model, students can be trained to acquire 4C skills of Critical Thinking, Creative Thinking, Communication and Collaboration by using LKPDs. To meet the needs of a 21st century, these 4C skills are vital for students.

Indicators for developing essential skills include indicators that enable students to solve problems according to applicable procedures and consider whether sources are trustworthy or not. current students are expected able to process that information obtained from internet media accurately and precisely so that it is not easy carried away by the rapid flow of information, where

there is still a lot of incorrect and inaccurate information (Nuraeni et al., 2019; Arung et al., 2022). Based on Table 3, students' critical thinking skills in the basic skills building indicator are included in the medium category. This shows that students are able to find solutions to problems regarding the reasons for the formation of two groups of emulsion type colloids and are able to characterize the types of colloids correctly.

The RADEC, which makes students learn to collect relevant information from a variety of sources that are applicable to colloidal material and solve problems independently, is what helps them develop basic skills during their learning process. This is what can help students to think critically by analyzing and considering whether the sources used are trustworthy or not, so that they are able to convey relevant information. This statement is in line with Agustiana (2019) who states that students who are able to think critically are students who are able to convey relevant information.

The RADEC has an answer stage which can train students to be able to make answers from sources that are suitable for colloidal material. In this way, students will be able to analyze information obtained from various sources so that students' critical thinking skills can improve. This is in line with Turan et al (2019) The statement states that a person's critical thinking skills can be improved by getting used to analyzing information, solving problems systematically, generating innovative solutions, thinking creatively, and communicating to others in a way that is easy to understand.

Making a conclusion means making a summary or final conclusion made after analyzing and identifying a topic or problem (Cahyani et al., 2021). The RADEC provides indicators for determining conclusions, e.g. at the answer and development stages. This indicator asks students to identify the properties of colloids that can be found in daily life. It shows that, by applying the RADEC of learning, students are able to develop their thinking skills so they can make decisions. This statement is in line with the statement by Nengsih et al (2023), The RADEC method of teaching, which encourages students to achieve high levels of knowledge and understanding so that they can complete the problem area, has a favourable impact on pupils through educational stages.

o assist understudies with learning imaginative reasoning and decisive reasoning abilities, the RADEC applied over the span of study can be utilized. According

to the statement Suratmi et al (2022) that the RADEC model requires students to apply critical thinking skills to create answers to the questions given. In this way, students can be trained to develop their thinking abilities so they can draw conclusions from a topic or problem.

In view of table 3, the marker for making ends is remembered for the moderate classification with the most minimal N-gain esteem contrasted with different pointers. This is on the grounds that understudies are as yet not used to applying the RADEC so that understudies' capacities in the pointer for making ends are as yet not ideal. Without practice and habituation, critical thinking skills cannot be acquired quickly. An understudy focused and critical thinking focused growing experience can assist with further developing decisive reasoning abilities in understudies. As stated by Sopandi et al. (2021), this RADEC is generally applied to students who already have initial reading skills. Thus, the application of this RADEC learning model is an initial step taken by researchers so that in the future they can achieve maximum results in all indicators of critical thinking skills if the RADEC learning model is applied continuously in learning.

The indicator for making further explanations is an indicator that can provide students with the opportunity to collect various kinds of relevant information and train students to make an appropriate explanation according to the concept. In this indicator, Students must be capable of defining terms and considering definitions based on appropriate criteria, as well as identifying underlying assumptions (Wayudi et al., 2020). This indicator is found in the RADEC, e.g. at the stage of answering. At this stage, students are given a problem and then asked to find as much information as possible to solve the problem and make conclusions about the properties of colloids and how to make colloids. Debates about the role of colloids can be provided by students and then relate the definition of colloid properties to their application in everyday life based on appropriate criteria and are also able to identify assumptions regarding how to make colloids correctly.

This can be accomplished by understudies since they have carried out the phases of the RADEC well, one of which is examine stage. Students learn to think openly, identify and analyze problems, and collaborate with others to solve problems at this stage. This is in line with research by Rahayu et al (2021) for the RADEC learning model, this refers to a discussion stage makes students

learn to think critically by recognizing and analyzing problems, then understanding the implications through the process of interacting with other people to find solutions to problem solving. It indicates that applying the RADEC of learning makes students able to analyse and apply information acquired in relation to the properties of colloids and their manufacture, thus enabling them to formulate a reasoned argument.

Signs of methodology and strategy the executives are pointers that can be utilized to prepare understudies' decisive reasoning abilities in managing an issue, distinguishing the important activities as per significant systems and reasonable sources (Arung et al., 2022). In this indicator, students are asked to categorize how to make colloids based on the correct procedure. This pointer is reflected in the phases of the RADEC, specifically examine and make stage. At the discussion stage, students discuss with their group of friends to solve problems in the LKPD that cannot be solved independently at home by determining answers from sources that are appropriate to the colloidal material. Then at create stage, students determine actions by determining ideas for making colloidal works, then making colloidal works according to the correct procedures.

Students are able to think critically in determining actions and discovering concepts. Students are able to categorize how to make colloids according to the correct steps. This indicates that the RADEC can assist students in developing critical thinking skills and actively participating in learning activities, as evidenced by from student responses where students are motivated and interested in learning that applies the RADEC. In line with the statement of Pratama et al (2020) that students learn more meaningfully when they are actively involved in teaching and learning activities, and that the RADEC can improve students' critical thinking skills over inquiry learning. discussion is very important in the article. The discussion focuses on discussing the research problem, linking the data and the results of its analysis with existing knowledge, and developing new theories or updating existing theories. Discussing is also the answer to the question of why facts are found as in the data.

4. CONCLUSION

Based on research data, data processing and analysis that has been carried out, it can be concluded that the RADEC applied to learning activities in this

research is effectively used to improve students' critical thinking abilities. However, this research has not yet obtained maximum results, namely the results of increasing indicators of students' critical thinking skills are still at a moderate level because students are not used to learning with the RADEC. Therefore, for further research, RADEC should be implemented sustainably so that students' critical thinking skills can be further improved.

5. ACKNOWLEDGEMENTS

The author would like to express his thanks to the teachers and principal of SMAN 5 Samarinda who have given permission to carry out this research, as well as the class XI students of SMAN 5 Samarinda who have participated in this research.

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