

The Effect of Multimedia-Assisted RADEC Learning Model on Critical Thinking Skills on Human Circulatory System Materials of High School Students

TRINOVA PUTRI RAMADHANI¹, HASRUDDIN², HASAN BASRI MATONDANG³

^{1,2} Universitas Negeri Medan, Medan, Indonesia

³ SMA Negeri 1 Binjai, Langkat, Indonesia

Corresponding Email: putritrinova@gmail.com

Abstract. This study aims to determine the influence of the multimedia-assisted RADEC learning model on critical thinking skills on the circulatory system material of SMA Negeri 1 Binjai, Langkat Regency. This type of research is a quasi-experiment and the experiment in this study uses the population, namely all students of Kelas XI SMA Negeri 1 Binjai, Langkat Regency. The sample of this study is 68 students consisting of two classes, namely experimental class XI IPA₂ and control class IPA₃ that are randomly taken. The test instrument used to determine critical thinking skills is in the form of multiple questions as many as 20 questions. The results showed that the multimedia-assisted RADEC learning model had a positive influence on student's critical thinking skills compared to the direct learning model. The results of the critical thinking ability score of the experimental class using the RADEC learning model obtained an average score of 81.18 while in the control class using the direct learning model, an average score of 72.35 was obtained. From the results of the hypothesis test, it was obtained that the significance value of critical thinking skills of the experimental class posttestes with the RADEC learning model and the control class posttestes with the direct learning model was 0.001. This result shows that the posttestes data $0.001 < 0.05$ which has the meaning of H_0 rejected and H_a accepted. So it can be concluded that there is an effect of the use of the multimedia-assisted RADEC learning model on student's critical thinking skills on the blood circulation system material of SMA Negeri 1 Binjai, Langkat Regency.

Keywords: Critical Thinking, RADEC, Circulatory System

Introduction

This century is also known as the all-digital era which can also be recognized by the development of various aspects, especially in the very rapid development of information and communication technology. The rapid development of this technology also has an impact on various other aspects of life so it is required to be able to keep up with these developments. Pratama (2020) stated that in order to be able to live in the 21st century, there are skills that students must have, these skills include creative thinking skills, critical thinking, metacognition thinking, communication, collaboration, information literacy, Information Communication Technology (ICT) literacy, citizenship, work and career, and individual and social responsibility skills.

The ability to think critically is one of the important things in living life in the 21st century. The results of the 2022 PISA test show that the average score of Indonesian students in these three fields is still in line with the global average. The average scores for math were 366, reading 371, and science 398, all of which were well below the OECD average. High-level thinking skills are activated when a person is faced with a new problem or information. Thus, this critical thinking ability is needed by students who can be learned and developed during the learning process at school (Hasruddin & Saputri, 2020).

Based on observations at SMA Negeri 1 Binjai, biology learning is still dominated by lecture methods that make students less active. As a result, students' understanding of complex concepts such as the circulatory system becomes less than optimal. Lack of stimulation for critical thinking and lack of confidence also hinder students' ability to answer questions and actively participate in biology learning. The learning model helps students in their cognitive development, especially critical thinking skills. As a result, inappropriate learning models will hinder students' cognitive development (Krishervina *et al.*, 2023). The use of innovative learning models in the teaching and learning process in the classroom is very important to improve the quality of education and students' abilities, including critical thinking skills. The use of innovative learning models, such as Problem-Based Learning (PBL) and Read, Answer, Discuss, Explain, and Create (RADEC), has a significant impact on improving students' critical thinking skills.

One of the learning models that can be applied is the RADEC learning model. Sopandi in 2017, offered an alternative learning model called RADEC as one of the solutions to overcome low understanding of concepts and to improve students' critical thinking skills (Setyawan *et al.*, 2023). This RADEC learning model has a characteristic that can build conceptual understanding, and critical thinking skills (Sopandi, 2019). According to Yulianti *et al.*, (2022) these characteristics include that the RADEC learning model can motivate students to be actively involved in learning activities, the RADEC learning model can direct students to be able to learn independently, the RADEC learning model can contextualize something that students know with the material they are learning, the RADEC learning model can connect the learning material by applying it to real life. The RADEC learning model emphasizes student-centered learning so as to create active learning, and provides opportunities for students before lessons are given pre-learning tasks to understand the subject matter in depth.

The results of the research conducted by Azizah *et. al* (2023) showed that the critical thinking skills of students in the experiment obtained an average N-Gain score of 0.75 in the high category and for the control class, which was 0.55 including the medium category with a difference of 0.20. The RADEC learning model has a positive and significant effect on students' critical thinking ability on reproductive system material. In conducting learning using a learning model, which in this case is the RADEC learning model, tools are also needed in the learning process in the form of learning media. One of the learning media that can be used in the teaching and learning process is multimedia-assisted learning. Multimedia is a combination of various media in the form of text, images, graphics, sounds, animations, videos, interactions and others that have been packaged into digital files (computerized), used to convey or transmit messages to the public (Munir, 2012). The results of research conducted by Pramuji *et al.*, (2018) show that multimedia can improve students' critical thinking skills, which is shown by the average pretest results of 9.69%, the average postes of 54.82% and the average %N-Gain of 49.90% which is included in the medium category (Pramuji *et al.*, 2020). Based on the descriptions above, it is considered important to conduct research with the multimedia-assisted RADEC learning model used to overcome the problems described above. With this multimedia-assisted RADEC learning model, it is hoped that it can answer the problems contained in the teaching and learning process in the classroom, especially in terms of increasing students' critical interest in the material of the human circulatory system.

Material and Method

This research was carried out using the Quasi Experimental Design research method. The design used in this study is a nonequivalent control group design. The design of this study

involves two groups of samples, one group as the experimental group and one group as the control group. can make research more effective and efficient (Mulyadi, 2012). In this study, the experimental group used the RADEC learning model and the control group used the Direct Learning Model. The population in this study is all students of XI SCIENCE SMA Negeri 1 Binjai, Langkat Regency. In this study, the sample is class XI IPA₂ and class XI IPA₃ with the number of students as many as 34 students each. The instrument is in the form of multiple-choice questions with a total of 20 questions. The data analysis technique uses quantitative data analysis, namely normality test, homogeneity test, hypothesis test using the Independent Sampe t Test, and Ngain test. Testing this data was carried out using the SPSS version 27.0 for windows program.

Results and Discussion

Results

Data on the pretest results of the experimental and control classes were obtained through scores after working on the test instruments totaling 20 questions. The data of the pretest results of the experimental and control classes can be seen in Table 1 as follows:

Table 1
Data of Pretest Results of Experiment and Control Class

Data	Pretest	
	Eksperimen	Control
Number of Students	34	34
Highest Scores	65	60
Lowest Rate	30	30
Average	48.97	48.24
Significance of <i>Independent Sample t-Test</i>	0.736	0.736

Based on Table 1, it can be seen that the average score for the pretest of the control class was 48.24 and the experimental class was 48.97. Then the results of the calculation of the *Independent Sample t-Test* with the test criteria, namely comparing the sig value. (2 tailed) <or> 0.05. The results of the pretest calculation obtained the results of sig. 0.736 > 0.05 which means that there is no significant difference between the pretest scores of the experimental class and the control class. The average score in the control class was 48.24 with the highest score of 60 and the lowest score of 30. The pretest test was carried out to determine the initial ability of students before the research was carried out. Based on the pretest data of the experimental and control classes, it can be concluded that there is no significant difference in the average score of the experimental class and the control class.

The pretest and postes data were then tested for normality using IBM SPSS *for windows version 27.0* before the hypothesis test, first a normality test and a homogeneity test were carried out. The results of the normality test can be seen in the following Table 2.

Table 2
Results of Pretest and Postes Normality Test

No	Critical Thinking Skills	Signifikan		Information
		Eksperimen	Control	
1.	Pretest	0.266	0.933	Normal
2.	Posttest	0.63	0,193	Normal

Based on the results of the normality test in Table 2, it is known that the probability value in the normality test in the *Shapiro-Wilk test* is 0.933 in the pretest value of the control class and the postes value of the control class is 0.193, then in the control class the significant value is > 0.05 and the data can be concluded to be normally distributed. The significance value of the normality test in the pretest of the experimental class was 0.266 and the postes value of the experimental class was 0.633, so in the experimental class the significance value was > 0.05 and the data could be concluded to be normally distributed. Based on the results of the normality test from the two data, the significance values of the two classes are normally distributed. The data that has been distributed normally will then be carried out a follow-up test, namely a homogeneity test. The results of the homogeneity test can be seen in Table 3.

Table 3
Homogeneity Test of Pretes and Posttest

Data	Class	Levene Statistic	df1	df2	Mr.	Conclusion
Pretest	Control and Experiment	3.248	1	58	0.76	Homogeneous
Posttest	Control and Experiment	1.427	1	66	0.237	Homogeneous

Based on Table 3 above, the significance value of the pretest in the control class with the direct learning model and the experimental class with the RADEC learning model was 0.76 and the postes in the control class with the direct learning model and the experimental class with the RADEC learning model was 0.237. The results obtained from the homogeneity test at the pretest of $0.76 > 0.05$ and the postes of $0.237 > 0.05$ then the data has the same or no different variance value or in other words that the data on critical thinking skills from the two class groups comes from a homogeneous sample. After the pretest and posttest data in both groups were declared normal and homogeneous, the two data were hypothetically tested to find out whether there was an influence of the multimedia-assisted RADEC learning model on critical thinking skills. The data from the hypothesis test results are in the following Table 4.

Table 4
Hypothesis Test Values (*Independent Samples Test*)

Group	Mean	$t_{computed}$	t_{table}	Sig (2-tailed)
Experiment	81.88	5.021	1.996	0.001
Control	72.35			0.001

Based on the *independent test of the sample t* test in Table 4, the price of the t-value of the table by finding the t-value of the table using the t-distribution table with $\alpha = 0.05 : 2 = 0.025$ and $db = N - 2 = 68 - 2 = 66$, then the t-value of the table = 1.996 is obtained. The t-value calculated in the table is obtained, then $5.021 > \text{value} = 5.021 > 1.996$ or the sig value (2-tailed) of $0.001 < 0.05$ is obtained, then the value of $0.001 < 0.05$ is obtained, thus $t_{computed} > t_{table}$ H_a it is accepted and H_0 rejected and it can be stated that there is an influence of the RADEC learning model on students' critical thinking skills. After the Independent Sample t Test test is carried out on the pretest results and postes of students' critical thinking skills obtained in the study, the average results are obtained and the Independent Sample t Test test in the control and experimental classes can be seen in Table 5 and Figure 1 below:

Table 5
Results of Hypothesis Test (*Independent Samples Test*) Pretest and Posttest

	Average	
	Pretes	Posts
Experiment	48.97	81.18
Control	48.97	72.35
Significance of <i>Independent Sample t Test</i>	0.736	0.001

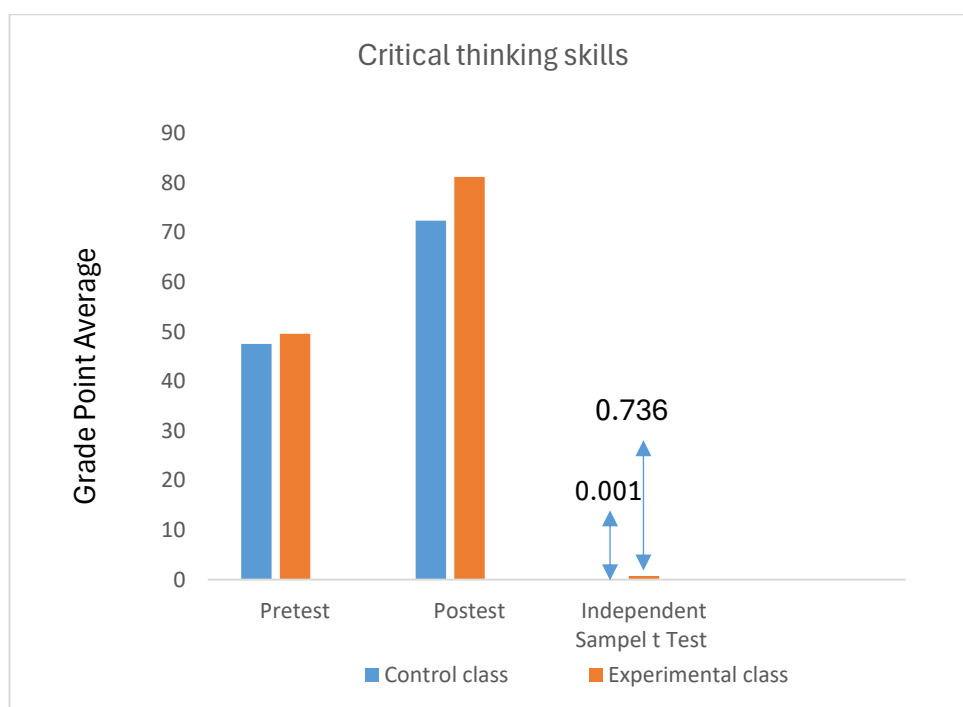


Figure 1. Critical Thinking Ability Assessment of Control Class and Experimental Class

To find out if there is an improvement in students' critical thinking skills, the N-gain score test is carried out by calculating the difference between the pretest score and the postes score. The results of the data calculation and the description of the N-Gain results in Table 6 are as follows:

Table 6
Calculation of Gain Data

	Experimental Classes	Control Classes
Gain Minimum	41.67	20.00
Maximum Gain	88.89	77.78
Variance	173.15	117.03
Average	62.78	47.26
NGain Effectiveness	Quite Effective	Less Effective

Based on the table above, it shows that the average N-gain score for the experimental class is 62.78 or 62.7% and if interpreted as effective, the Ngain score in the experimental class is included in the interpretation **is quite effective**. With the minimum score in the experimental class is 41.67% and the maximum score is 88.89%. As for the score of Ngain in the control class, the average score is 47.26 or 47.2% and if interpreted the effectiveness of the score of Ngain in the control class is included in the **interpretation of less effective**. Therefore, it can be concluded that the use of the RADEC learning model is quite effective in improving students' critical thinking skills on the material of the human circulatory system. The results of the independent test sample test for Ngain are known to have sig. (2-tailed) is $0.001 < 0.05$. So it can be concluded that there is a significant (real) difference in effectiveness between the use of the RADEC learning model and the direct learning model to improve the critical thinking ability of circulatory system material students of SMA Negeri 1 Binjai, Langkat Regency.

Discussion

The improvement of students' critical thinking skills in the experimental class is due to the fact that the RADEC learning model has met the requirements of 21st century learning where the learning center is the student. The Read, Answer, Discuss, Explain, and Create (RADEC) learning model is a learning model with stages of reading, answering, discussing, explaining, and creating (Zulfa et al., 2021). According to (Putri *et al.*, 2024) said that the RADEC learning model was developed as an innovative learning model and is suitable for use in 21st century learning because it can respond to or facilitate students' needs in honing skills, improving cooperation, and solving problems. This is also supported by the opinion (Sopandi, 2019) that through this learning model, students can be equipped with high-level skills, stimulate students' independent learning activities, develop communication and collaboration skills, and provide an understanding of the material. The use of the RADEC learning model in this experimental class has a positive influence on students' critical thinking skills.

The improvement is quite significant in the experimental class because the RADEC learning model has a syntax that is in accordance with the characteristics of Indonesian students. Based on the research that has been conducted, each stage of the RADEC learning model is well implemented, with several stages improving at each meeting and several stages having been implemented optimally (Agustina et al., 2024). The syntax of the RADEC learning model begins with the *Reading* stage where students will read through various sources related to the material to be learned on that day. Reading activities are an alternative to foster students' reading habits (Wiguna et al., 2022).

Then for the second stage is *the Answer* to see student feedback at the *Read* stage. Students are given pre-learning questions to students to help students understand the material

to be studied according to the topic they have read. The third stage, namely *Discuss*, (Yulianti et al., 2022) states that the discussion stage can provide both in terms of training and developing students' knowledge and skills in understanding a concept. The experimental class that applies the RADEC learning model has sufficient preparation for the discussion process. This is related to the learning syntax that was carried out previously. The provision of pre-learning questions can stimulate students to improve their understanding of the reading and concepts to be learned so that it can increase students' readiness and activeness in learning, as well as encourage students to criticize and analyze each question (Maspiroh & Eddy Sartono, 2022).

This is the fourth stage in the RADEC learning model, namely *Explain*, where students will present the results of their discussions. At this stage, the teacher also gives additional explanations to students when the explanation during the presentation is not understood by other students using multimedia. The multimedia used in this study is in the form of interactive videos and 3D animations. The use of multimedia can also improve critical thinking skills explained by (Toharudin, 2024) stating that using interactive multimedia can improve students' ability to excrete materials.

The application of the multimedia-assisted RADEC learning model can improve students' critical thinking skills. From the results of the research conducted (Table 4), it can be seen that the value of Ngain in the experimental class is higher than in the contrarian class which is 47.26. In addition, Abdullah et al., (2021) also concluded that the use of multimedia can improve students' critical thinking skills with good category results and higher average scores after the critical thinking skills test in the experimental class than in the control class. In addition, based on the interactive multimedia effectiveness test based on problem-based learning using an independent test, it is proven that there is a significant difference in the post-test scores of students' critical thinking skills in the experimental class and the control class. From the use of this multimedia, students can see and understand the material more clearly. The use of multimedia such as videos and 3D animation can make students see an overview of how the circulatory system in the human body works.

The last stage of the RADEC learning model is *Create*. In this *Create* stage, students are asked to make a work that has been agreed upon beforehand. At this stage, students are asked to cooperate, be cooperative, collaborate, and communicate. The activity in this stage is to develop students' creative ideas in product making activities. This is also explained by Handayani *et al.*, (2019) who stated that the RADEC learning model can improve students' creative thinking skills. Tulljanah (2021) added that there is a relevance between the RADEC model and critical thinking skills, namely at the Create stage, students' creative thinking skills will be able to be built. Critical thinking skills are part of *higher order thinking skills* that are important to develop. This critical thinking ability can help students solve problems by thinking actively and carefully to study the various information obtained. Therefore, to improve this ability starts from the world of education. Education is very important to develop competent and superior human resources. The key to keeping up with the times is education, which starts from elementary and secondary schools and continues to higher education (Mardhiyah et al., 2021).

Conclusion

From the results and discussion of the use of the multimedia-assisted RADEC learning model on students' critical thinking skills on the human circulatory system material, it can be concluded that the level of critical thinking ability of students in the experimental class after using the RADEC learning model obtained an average result of 57.38 which is included in the

category of quite effective. As for the level of critical thinking ability of students in the control class after using the direct learning model, the average result was 46.77 and was included in the less effective category. Furthermore, there is an influence of the multimedia-assisted RADEC learning model on students' critical thinking skills on circulatory system material. This is evidenced by the results of hypothesis tests with a significance value $0.001 < 0.05$.

Acknowledgements

With the completion of this research, we would like to express our deepest gratitude to all parties who have made a very meaningful contribution, both in the form of participation, motivation, assistance, and direction that are very valuable for the smooth running of this research.

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