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Implementation Of Focus Explore Reflect Apply (FERA) Learning Model Assisted Crocodile Physics In Improving Students' Critical Thinking Skills

Siti Nurhalimah [1], Aripin [2], Rahmat Rizal [3*)]
Universitas Siliwangi, Indonesia [1,2,3]
[*)]Corresponding E-mail: rahmatrizal@unsil.ac.id

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ABSTRACT
This study aimed to determine the effect of the Focus Explore Reflect Apply (FERA) learning model assisted by crocodile physics media on students' critical thinking skills on sound waves material and to determine the increase in critical thinking skills in students on sound waves material in class XI IPA SMA Negeri 1 Cihaurbeuti. The research method used was quasi-experimental with a research design non-equivalent control group design. The population of this study was all XI IPA classes, as many as seven classes, using purposive sampling techniques, selected as many as two classes, namely XI IPA 3 as the experimental class and XI IPA 2 as the control class. The essay test was conducted before and after treatment with nine questions on sound wave material to measure critical thinking skills. The essay question includes five indicators of critical thinking skills. The data analysis techniques used are prerequisite tests (normality test, homogeneity test) and hypothesis testing (t-test). The results of hypothesis testing using the t-test showed that after the application of the Focus Explore Reflect Apply (FERA) learning model assisted by crocodile physics media, $t_{count} > t_{table}$ *(3.74> 1.6), so* H_o *is rejected and* H_a *is accepted. It means that applying the Focus Explore Reflect Apply (FERA) learning model assisted by crocodile physics media is proven to affect critical thinking skills in sound wave material. Improved critical thinking skills can be seen from the results of the N-Gain, where both classes are in the medium category, but the experimental class scores are more significant than the control class.*

INTRODUCTION

The current development era demands that society adapt to various conditions by strengthening critical thinking skills in solving problems [1]. The demands of the 21st century require society to have

several 4Cs competencies: communication, collaboration, critical thinking and problem-solving, and creativity [2]. Industrial Revolution 4.0 also provides new demands by combining physical, digital, and biological technologies that completely change people's lives. The learning system in Revolution 4.0 must involve creativity, critical thinking, cooperation, communication, community, and character skills [3]. Purnamasari & Hanifah [4] stated that to achieve Sustainable Development Goals (SDGs) through education is to train eight skills: systems thinking, anticipatory, normative, strategic, collaboration, critical thinking, self-awareness, and problem-solving.

Critical thinking skills are important in education, which is realised in learning activities, including in physics. Learning in school is very much one of them in the natural sciences. Science is a field of science that discovers natural laws to master knowledge, facts, concepts, principles, discovery processes, and scientific attitudes. One of the fields of science is physics, which teaches the most basic science of the universe, which underlies astronomy, biology, chemistry, and geology. Physics is one of the subjects in the exact category that students can use to measure their ability to solve a problem [5]. Physics plays a role in everyday life; almost every human activity will not be separated from physics in daily activities or natural phenomena [6]. With all its uniqueness, learning physics should provide opportunities for students to practice critical thinking skills with several scientific work activities.

Physics learning that often occurs is more teacher-centered. In the learning process, students are directed to think critically in identifying facts, processing ideas, and concluding existing problems to gain a deeper understanding of physics. In reality, the most students only listen to explanations from the teacher, which makes students assume that physics is a complex subject because many equations are memorised and boring learning [7]. Students also find it challenging to connect one concept with another, causing critical thinking skills not to develop in learning. Students' learning habits also cause critical thinking skills not to develop [8]. The learning process in schools generally does not apply critical thinking in every lesson, so students are less accustomed to doing critical thinking activities [9]. Therefore, it is necessary to habituate critical thinking and be trained gradually and continuously so that students can think and find problems and solutions to these problems.

Based on test results, this condition impacts the low level of critical thinking skills. Using a test that includes Ennis' version of critical thinking skills indicators (elementary clarification, essential support, inference, advanced clarification, and strategy and tactics) [10], the score results are obtained as shown in Table 1.

Table 1. Percentage of Student Critical Thinking Ability Test Results

No	Indicator	Percentage (%)	Category
1	Elementary clarification	50.69	Less
2	Basic support	43.06	Less
3	Inference	42.36	Less
4	Advanced clarification	38.19	Very less
5	Strategy and tactics	41.67	Less
Average		**43.19**	**Less**

Based on the information in Table 1, the percentage results for each stage of critical thinking skills obtained an average percentage of 43.19%; this percentage is still included in the insufficient category. So, it can be concluded that students' critical thinking skills are still low.

To overcome students' low critical thinking skills, learning activities that are student-centred and refer to constructivist learning are needed. One learning model with these characteristics is the FERA learning model developed by the National Science Resources Center (NSRC) [10]. FERA provides opportunities for students to build their knowledge so that apart from being able to train to understand, students can also practice thinking skills and provide opportunities to be actively involved in gaining or processing their knowledge [11].

In practice, learning models are built by solving problems proven through experimental activities so that effective tools are needed. Due to limited experimental equipment in schools, practical activities are required as an alternative. One provider of virtual experiment facilities is Crocodile Physics. Maulida [12] states that crocodile physics media is a 3D simulation software tool that includes physics, ICT, and programming used to conduct experiments. This crocodile physics media is one of the uses of technology that can provide better learning. Apart from that, crocodile physics learning media can help the effectiveness of learning, can train students' critical thinking during practicums and can be tested to prevent failure during the practicum process in the classroom.

The material chosen in this study is sound waves because interview results show that sound wave material is complex for students to understand. Besides that, laboratory activities did not appear to facilitate students' learning. The selection of sound wave material is also corroborated by the opinion of Dwipangestu [13] who states that teachers find it difficult to explain to students how sound waves propagate from one place to another. Other difficulties experienced by students lie more in understanding concepts related to basic concepts in wave material, such as the concept of wave propagation superposition [14] [15]. The difficulties experienced are shown by the students' daily test results, which are still not good because only 24.14% of students scored above the minimum completion requirements in the wave material. So, these difficulties require a learning media for research related to crocodile physics media.

Based on the explanation in this introduction, this study aims to see the effect and improvement of students' critical thinking skills using the FERA learning model assisted by crocodile physics media on sound wave material.

METHOD

This research focused on the class XI IPA students at SMA Negeri 1 Cihaurbeuti. The study used a quasi-experimental method, which included a control class that did not have complete control over external variables affecting the experiment. The sample for this study was determined using purposive sampling, which means the selection is based on specific considerations and does not provide equal opportunities for each population [16]. The experimental and control classes were not selected randomly. After analysing the average values and standard deviations of the seven classes, it was determined that class XI IPA 3 would be the experimental class and class XI IPA 2 would be the control class, as they had similar average values and little standard deviations.

The research design used in this study is a non-equivalent control group design. Each experimental group and control group was given a pretest then after being given treatment in the experimental class using the FERA learning model assisted by crocodile physics media and in the control class using a learning model that is commonly applied in schools, namely direct instruction then given a post-test. In this study, there are two variables, namely, the independent variable and the dependent variable. The independent variable in this study is FERA learning model assisted by crocodile physics media, while the dependent variable is students' critical thinking skills.

The data collection technique used in this study was a critical thinking skills test in the form of an essay test conducted before and after applying the learning model. The way to calculate students' final score of critical thinking skills is presented in the form of a percentage value. These percentage values will be interpreted as categories shown in Table 2.

Table 2. Critical Thinking Skills Categorisation

Percentage (%)	Category
85 – 100	Very good(A)
70 – 84	Good (B)
55 – 69	Enough (C)
40 – 54	Less (D)
0 – 39	Very less (E)

Two data analyses will determine how the FERA learning model with crocodile physics influences critical thinking skills. The first data analysis was carried out to test the hypothesis through a series of tests: normality, homogeneity, and t-tests. The second data analysis is to determine the increase in critical thinking skills using N-Gain analysis through equation (1)

$$N - Gain = \frac{Posttest\ score - Pretest\ score}{Ideal\ score - Pretest\ score} \quad (1)$$

The N-Gain category can be found in Table 3.

Table 3. Category of Normalised N-Gain Level [17]

N-Gain value	Category
$G > 0.7$	High
$0.3 \leq g \leq 0.7$	Low
$G < 0.3$	Medium

RESULTS AND DISCUSSIONS

After the trial was conducted and the results were known, it was continued by taking data on the initial ability of students' critical thinking through a pretest in the experimental class (students of XI IPA 3) and the control class (students of XI IPA 2). The pretest results are described in Table 4.

Table 4. Statistics of Student Critical Thinking Ability Pretest Results

Statistical Data	Class	
	Experimental	Control
Minimum score	11	11
Maximum score	22	22
Average	16.67	15.94
Variance	6.52	5.89
Standard deviation	2.55	2.43
Number of data	36	36

Based on the statistical results of the pretest of critical thinking skills of the experimental class and control class in Table 3, it shows that in the experimental class and control class, almost all students have the same understanding, meaning that between the experimental class and the control class the distribution of student score data has a low level of distribution because it is close to the average value and the number of different data is also small in other words the data is less varied, which means that the acquisition of the average pretest score between the experimental class and the control class obtained the score of the two classes is almost the same or has nearly the same level of homogeneity.

The experimental class was treated with the FERA learning model assisted by crocodile physics media. In contrast, the control class used the learning model commonly used in schools: conventional learning (direct instruction). Based on the post-test results, namely after applying the learning model to the experimental and control classes with sound wave material, data were obtained with description in Table 5.

Table 5. Statistics of Post-test Results of Students' Critical Thinking Skill

Statistical Data	Class	
	Experimental	Control
Minimum score	17	15
Maximum score	27	26
Average	22.92	20.75
Variance	4.99	7.16
Standard deviation	2.23	2.67
Number of data	36	36

The statistical results comparing the post-test of critical thinking skills between the experimental and control classes showed noticeable differences. The post-test data's standard deviation and variance values were lower in the experimental class than in the pretest data. This result indicates that after using the FERA learning model with crocodile physics media, the student's understanding was more centred around the average score and less variability among the students. On the other hand, in the control class, the standard deviation and variance values in the post-test data were more significant than the pretest data. This condition suggests less centrality around the average score among the students after using the direct instruction learning model and more variability. Overall, this means that the FERA learning model assisted by crocodile physics media was influential in promoting a more homogeneous understanding among the students in the experimental class. In contrast, the direct instruction learning model had a weaker impact on promoting uniform knowledge in the control class.

After obtaining data on the results of the pretest and post-test of students from the experimental and control classes, the prerequisite test, namely the normality and homogeneity tests, is first carried out. The normality test using the Chi-Square test was conducted to determine the normality of the research data. The result of the normality test can be seen in Table 6.

Table 6. Chi-Square Normality Test Results

Data	x^2_{count}	x^2_{table}	Conclusion
Posttest Experimental	6.34	7.81	Because the value of $x^2{}_{count} < x^2{}_{table}$ then data is normally distributed
Posttest Control	5.25		

Based on the calculations in Table 6 using Microsoft Excel 2019, the value of $x^2{}_{count}$ in the experimental class for the post-test is 5.54, and in the control class is 3.71, while the value of $x^2{}_{table}$ is 7.81. Because the value of $x^2{}_{count} < x^2{}_{table}$ both in the experimental and control classes, it can be concluded that all data groups have been taken from normally distributed populations.

The homogeneity test was conducted to determine whether the data groups tested had the same variance using the Fisher test with the help of Microsoft Excel 2019 with a significant level of 5%. The data tested was the post-test in the experimental and control classes. The analysis results of the homogeneity test can be seen in Table 7.

Table 7. Fisher Homogeneity Test Results

Data	F_{count}	F_{table}	Conclusion
Posttest Experimental	1.31	1.76	Because of the value of $F_{count} < F_{table}$, then all variances are homogeneous
Posttest Control	0.82		

Based on the calculations in Table 7 using Microsoft Excel 2019, it shows that the F_{count} value in the experimental class is 1.31, and in the control class is 0.82, while the F_{tabel} value is 1.76. Because the value of $F_{count} < F_{table}$, it can be concluded that all data groups have the same variance or homogeneous.

After going through the prerequisite test (normality test and homogeneity test), it was found that the data of both samples were normally distributed and had homogeneous variances. Therefore, hypothesis testing can be continued using the t-test. The results of the hypothesis testing analysis using the t-test can be seen in Table 8.

Table 8. Free Sample t-test Results

Data	t_{count}	t_{table}	Conclusion	Analysis conclusion
Posttest CTS score (Experimental-Control)	3.74	1.67	H_a accepted	The FERA learning model assisted by crocodile physics media has affected critical thinking skills on sound wave material.

Table 8 shows that the results of hypothesis testing with the help of Microsoft Excel 2019 show that the results of hypothesis test calculations using the t-test with a significance level of 0.05 were obtained. $t_{count} > t_{table}$, namely $3.74 > 1.67$, so H_o is rejected and H_a is accepted. This result means that at the 95% confidence level, it can be concluded that there is an effect of the Focus Explore Reflect Apply (FERA) learning model assisted by crocodile physics media in improving critical thinking skills on sound wave material in class XI IPA SMA Negeri 1 Cihaurbeuti in the 2022/2023 school year significantly.

The results of the experimental class and control class post-test data can be explained in more detail by calculating the average percentage of post-test scores per indicator, and the percentage is obtained from the post-test results, which consist of 9 essay questions with questions covering five aspects of students' critical thinking skills. The calculation results are in Table 9.

Table 9 Comparison of Post-test Score Percentage Per Indicator of CTS in Experimental and Control Classes

Critical thinking skills aspects	Experimental class		Control class	
	Percentage	Category	Percentage	Category
Elementary Clarification	90.27%	Very good	91.20%	Very good
Basic Support	86.11%	Very good	83.33%	Good
Inference	82.87%	Good	73.14%	Good
Advanced Clarification	82.98%	Good	68.86%	Enough
Strategies and Tactics	85.19%	Very good	74.07%	Good
Average	85.16%	Very good	77.44%	Good

Table 9 shows that applying the FERA model assisted by crocodile physics media in the experimental class improves critical thinking skills, with an average score more significant than the control class. So, it can be concluded that using the FERA learning model assisted by crocodile physics media can improve students' critical thinking skills on sound wave material.

The N-Gain test is used to determine whether there is an increase in students' critical thinking skills after being given learning activities. The N-Gain value in this study was obtained as in Table 10.

Table 10. N-Gain Test Results Per Aspect of Critical Thinking Skills

Critical thinking skills aspects	Experimental class	Category	Control class	Category
Elementary Clarification	0.32	Medium	0.45	Medium
Basic Support	0.62	Medium	0.51	Medium
Inference	0.42	Medium	0.25	Medium
Advanced Clarification	0.95	High	0.54	Medium
Strategies and Tactics	0.75	High	0.57	Medium
Average	0.61	Medium	0.46	Medium

Based on **Table 10**, the average results of the N-Gain test of the two classes are within the limits of

$0.3 \leq g \leq 0.7$ with a moderate category, but the size of the N-Gain value is different. The experimental class has an N-Gain value of 0.61, while the control class has an N-Gain value of 0.46. This result shows that there is an increase in critical thinking skills in the experimental class, namely by using the FERA learning model assisted by crocodile physics media on students' critical thinking skills on sound wave material in class XI IPA SMA Negeri 1 Cihaurbeuti in the 2022/2023 school year.

Compared to a control class, the study analysed the effectiveness of using the the FERA model with crocodile physics media, the experimental class generally outperformed the control class across all aspects. However, when examining the data in categories, there were certain discrepancies. Specifically, the second, fourth, and fifth aspects had better categories in the experimental class than in the control class. Yet, the first and third aspects shared the same category as the control class, although the percentage results differed. This condition can be attributed to the FERA learning model, which incorporates critical thinking skills. In the initial focus phase, the teacher presents problems to students, prompting them to connect their prior knowledge or experiences to a concept and generate ideas or predictions. This focus phase encompasses two critical thinking skills: providing explanations and strategies, where students learn to focus on questions and employ appropriate strategies and tactics to answer them. This condition is also supported by Mundilarto [18] that thinking is not only about how someone can answer a question under certain conditions but also about how to get answers and solutions or new thoughts systematically and precisely. So that critical thinking skills must be honed from an early age.

The given text discusses three different syntaxes in a learning process using Crocodile Physics media. The first syntax is an introduction, where students are introduced to new concepts or ideas through Crocodile Physics. The second syntax is explore, where students are encouraged to conduct experiments using the Crocodile Physics media to test the ideas they have learned. This syntax aims to develop critical thinking skills, particularly building basic skills through observation and interpretation of results. Lastly, the third syntax is reflect, in which the teacher guides students in processing data from the explore activities. Students answer questions on the Learner Worksheet and conclude to answer existing problems. This syntax also emphasises three aspects of critical thinking skills, including building basic skills, drawing conclusions, and making further explanations. The reflect syntax encourages students to communicate and discuss their findings, enabling them to make informed conclusions based on their gathered data and assumptions. Putratama et al. [19] explained that experimental methods can improve critical thinking skills and concept mastery. Through experimental or practicum activities, students can do it themselves, follow a process, observe an object, analyse, prove, and draw conclusions. These results are supported by research by Cahyono et al. [20], which states that students who are active during learning activities will more easily capture and understand what students learn.

The apply syntax in teaching involves guiding students to expand on concepts learned in other contexts or apply concepts to everyday life. This syntax helps students better understand the concepts by using appropriate strategies and tactics. The apply syntax focuses on two aspects of critical thinking skills: providing further explanations and using strategy and tactics to connect the material to real-life situations. According to Halpern [21], critical thinking is essential for problem-solving and decision-making in complex cases commonly encountered in everyday life. Therefore, the experimental class outperforms the control class, which focuses on the three aspects of critical thinking skills (building basic skills, using strategies and tactics, and providing further explanations).

In the control class, the cause of building basic skills, strategies, and tactics is in a good category. The element of making further explanations is in the sufficient category because the control class still uses direct instruction, namely teacher-centred learning. The teacher does not focus students on discussion activities because no activities in the experimental class provide stimulus at the beginning of learning. There are no presentation activities for student discussion results, so students are not used to predicting and are still not optimal in making conclusions.

Based on the discussion above, research using the FERA learning model assisted by crocodile physics media affects students' critical thinking skills on sound wave material. It can improve students' critical thinking skills on sound wave material. This condition can happen because the experimental class applied the FERA learning model assisted by crocodile physics media. In contrast, the control class still used the conventional model (direct instruction). The FERA learning model assisted by crocodile physics media is also appropriate for learning Physics on sound waves in class XI IPA SMA Negeri 1 Cihaurbeuti. These results are evidenced by the average post-test score and the average percentage of post-test scores per indicator of students' critical thinking skills using the FERA learning model assisted by crocodile physics media is higher than the average post-test score and the average percentage of post-test scores per indicator using the direct instruction learning model. This condition follows research conducted by Putri, which states that the FERA learning model effectively improves students' critical thinking skills [19].

CONCLUSION AND SUGGESTION

According to the research, the FERA learning model combined with crocodile physics media can enhance students' critical thinking skills in sound waves. The researchers concluded that this learning model positively impacts students' critical thinking abilities, specifically in the medium category. The study suggests that educators using the FERA learning model with crocodile physics media should provide guidance and direction to students during the exploration stage to ensure that experiments are conducted as planned. Additionally, researchers are advised to review the question instruments used in the study to ensure that they are easily understandable for students. Overall, this research highlights the potential benefits of the FERA learning model with crocodile physics media in improving critical thinking skills for students studying sound waves.

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