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The Effect Of The Practicum-based Learning Cycle 5E Learning Model on Critical Thinking Skills on Mechanical Wave Material

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Abstract

This study aims to determine the effect of learning model learning cycle 5e practicum-based critical thinking skills on mechanical wave material. The low ability of critical thinking is a problem experienced by students of Class XI science, which was the background for researchers to use the 5e learning cycle model based on practicum. This study used a quasi-experimental method with a pretest-posttest design; the sample was determined using a cluster random sampling technique from a population of 180. Testing data using normality test, homogeneity test, and T-test. The findings indicated that t_count = 7.31 and t_table = t ((0.995) (65)) = 2.65. The fact that H_0 is rejected and H_a is approved shows that the practicum-based 5E learning cycle learning model impacts students' critical thinking abilities about mechanical wave content. This is because the value of t_hitung > t_tabel. This is so that students may practice critical thinking skills at various phases of the practicum-based 5E learning cycle learning model. Students get instruction in the fundamentals of clarification at the phases of engagement, investigation, explanation, and elaboration. Students get instruction in inquiry, explanation, elaboration, and assessment as they pertain to the fundamental factors of the choice. Students get instruction in the investigation and explanation phases of the conclusion element. The benefit of this study is that it may serve as a reference for future studies on the impact of the 5E learning cycle's practicum-based learning model on students' critical thinking abilities about mechanical wave content.

Keywords: 5E Learning Cycle; Critical Thinking Skills; Learning Model; Mechanical Wave; Practicum

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INTRODUCTION

Technology, information, and communication in various living activities have become a hallmark of 21st-century development (Malik et al., 2017; Binkley, 2012; National Research Council, 2012). Developments in the 21st century certainly impact education because the learning process also needs to adapt to changes. Therefore, students must have skills in dealing with education in the 21st century (Djamas et al., 2016; Devkota, 2017; Sari, 2022).

In the twenty-first century, four talents are very important: creativity, cooperation, communication, and critical thinking. It needs critical thinking abilities to evaluate if the material is accurate. Students still have poor critical thinking abilities, nevertheless. Students' destitute basic considering capacities are affected by the less expanded education strategies teachers utilize (Al-Seghayer, ,2014; Lestari & Apsari, 2022; Gorski, 2017). According to Yuningsih & Suratmi (2016), Only 28% of pupils have strong critical thinking abilities. Moreover, according to Suci et al. (2022), among pupils, 21% have intermediate critical thinking abilities, 64% have poor critical thinking abilities, and 15% have very low critical thinking abilities. While two indications of critical thinking abilities fall into the medium group and six indicators fall into the low category, the study of each indicator of critical thinking skills yielded these findings. Preliminary studies have been conducted in Class XI through interviews with teachers and critical thinking tests on students. According to the findings of an interview with a physics teacher at SMA Negeri 1 Jalaksana, the level of pupils' critical thinking abilities is still rather poor. On mechanical wave material, the average daily Test score for students in 2021 is 56, which is still relatively low. The average score of students on mechanical wave material still has not reached KKM, which is 75. This means that students still have not reached the competency standard.

Preliminary studies have been conducted in Class XI through interviews with teachers and critical thinking tests on students. According to the findings of an interview with a physics teacher at SMA Negeri 1 Jalaksana, the level of pupils' critical thinking abilities is still rather poor. On mechanical wave material, the average daily Test score for students in 2021 is 56, which is still relatively low. The average score of students on mechanical wave material still has not reached KKM, which is 75. This means that students still have not reached the competency standard.

According to the preliminary survey, 87% of pupils still had very poor critical thinking abilities, 11% had low critical thinking skills, and 2% had intermediate critical thinking skills.

These problems require solutions in the form of learning models that can make students active in learning and have a student-centered activity Stage (student center) to overcome difficulties in critical thinking. The Learning Model is that which is constructivism. The constructivist learning model focuses on students' activeness, and students must build their knowledge with the help of their social environment (Malik et al., 2019). One of the relevant learning models is the practicum-based learning cycle 5e learning model.

According to Setiyani et al. (2022) and Ghareb (2015), the arrangement of exercises of the 5e Learning Cycle demonstrates points for understudies to ace competencies and be more dynamic in learning. The arrangement of exercises within the Learning Cycle 5e learning demonstration includes understudies effectively in learning so that this demonstration can overcome the issue of basic considering abilities. According to Denny et al. (2020), Asrizal (2022), and Herman (2017), the right solution to overcome the problem of low critical thinking ability of students is to apply the 5e learning cycle model. A series of learning activities in the learning cycle 5e model, there is an exploration phase to provide student experience to build knowledge through the activities of the science process (Arifin et al., 2020).

As an activity researchers use in the exploration stage, practicum aims for students to explore and find the theory to be studied. Practicum is very important in the learning process. Practicum-based learning leads students to experiments

and discussions to obtain new ideas and concepts (Hujjatusnaini, 2022; Lina & Desnita, 2022; Pamenang, 2020).

This study differs from the others because in the 5e model, especially at the exploration stage, students explore their knowledge in various ways, such as by demonstration, observation, and practicum. The researcher chose practicum in the exploration stage, so this model is based on practicum. Practicum is the application and proof of the truth of a theory. With practicum, understudies discover their claim information so that learning becomes important and students have long-term knowledge (Bell, 2013; Fabrisera, 2021; Ritdamaya & Suhandi, 2016). In practical activities, students must actively learn to develop critical thinking skills in analyzing, concluding, and answering teacher questions (Ibrahim, 2017; Kaddoura, 2013; Retnawati, 2018). Activities that can make students active in learning is a practicum. This is in line with the opinion of (Bakri, 2020; Duda, 2019; Royani et al., 2018) that practicum-based learning makes students active in the learning process so that students can think critically in analyzing and concluding practicum results.

Similar research (Ajaja, 2013; Andariana 2019; Lina & Desnita, 2022) showed that using the learning cycle 5e learning model can improve students ' critical thinking skills more than the Stad type cooperative learning model.

This study is very important because it can be used as a reference in overcoming students' low critical thinking skills on mechanical wave material. This ponders points to decide the impact of learning show learning cycle 5e practicum-based basic considering aptitudes of understudies in Lesson XI on mechanical wave fabric.

METHOD

This consideration could be a quantitative investigation with semi exploratory (Swedberg, 2020) strategy utilizing the pretest-posttest control bunch plan. The population of this study is Class XI science students, as many as 180 students. The study was conducted in April 2022. The cluster irregular inspecting method is utilized to decide the test of investigate to get tests of two classes, specifically Course XI IPA 3 as a test course and Lesson XI IPA 2 as a control lesson. These two classes have the same number of students at 36. The sample is selected by polling several classes of the population. The first draw will be the experimental class, and the second will be the control class. Test lessons will get treatment within the learning frame, demonstrating learning cycle 5e based on practicum. As for the control class using a direct instruction learning model based on practicum. To collect data, the researchers used an instrument of test questions adjusted to the indicators of critical thinking skills, as many as 12 questions. The 12 questions are essay questions. The time in the experimental and control classes was 2 hours of lessons during two meetings.

Perspectives of basic considering aptitudes utilized are essential clarification, the basis of decisions and conclusions. For basic clarifying aspects, there are indicators of focus on questions, analysis of arguments, asking and answering clarifying questions, and understanding and using basic graphs. At the same time, the basic aspects of the decision consist of assessing the source's credibility, observing and assessing the observation report, and using existing knowledge. The conclusion consists of formulating and assessing deduction indicators and inductive argument conclusions and judgments (Maison et al., 2022; Ramadhana, 2018; Supena, 2021). The taking after are the criteria for basic considering abilities concurring with Dwijananti et al. (2010). The criteria for critical thinking skills presented in Table 1.

Table 1 Criteria of critical thinking skills according to Riduwan (Khasanah, 2017)

Interval Score (%)	Criteria
80< T ≤100	Excellent
60< T ≤80	Good
40< T ≤60	Enough
20< T ≤40	Less
0< T ≤20	Very Less

The Pretest post-test instrument is tested first using validity and reliability tests. A validity test measures the similarity between the data collected and the actual data in the field. A valid instrument will produce valid data; this means that the instrument can be used to measure what should be measured (Sarwono & Handayani, 2021; 2023; Mohajan, 2017). Validity and reliability tests were measured using research instruments with as many as 12 questions according to indicators of critical thinking skills that three experts have validated. The taking after Item minute relationship equation from Pearson is displayed to discover the relationship coefficient of the instrument test comes about with the test criteria (Sarwono & Handayani, 2021). The value of this coefficient is referred to as the validity coefficient. The interpretation of the value of r_{xy} can be seen in Table 2.

Table 2 Interpretation of the correlation coefficient

Correlation Coefficient	Interpretation
$0.00 < r_{xy} \leq 0.20$	Very low
$0.20 < r_{xy} \leq 0.40$	Low
$0.40 < r_{xy} \leq 0.60$	Medium
$0.60 < r_{xy} \leq 0.80$	High
$0.80 < r_{xy} \leq 1.00$	Very High

(Arikunto et al., 2012)

The instrument must be dependable, meaning that if the instrument is utilized a few times to a degree, the same protest will create the same information (Chander, 2013). the reliability test can be calculated using the following reliability test formula (Cronbach's Alpha). According to Guilford, the test device has a high low coefficient of reliability using the index yardstick. Researchers present in Table 3.

Table 3 Interpretation of reliability values

Range	Interpretation
$0.00 < r_{11} \leq 0.20$	Very low
$0.20 < r_{11} \leq 0.40$	Low
$0.40 < r_{11} \leq 0.60$	Medium
$0.60 < r_{11} \leq 0.80$	High
$0.80 < r_{11} \leq 1.00$	Very high

(Arikunto, 2012)

The collected information was analyzed utilizing prerequisite tests and theory tests. The prerequisite test comprises a typicality test and a homogeneity test, whereas the speculation test employs a diverse Test (t-test). A typicality test is utilized to decide whether or not the information has been conveyed. The ordinariness test is calculated by the factual equation chi-squared.

The change homogeneity test is utilized to decide whether a test comes from a populace with the same change or not. The objective is to decide the closeness of the starting capacity of understudies within the test course and the control course. To test it using Fisher's formula.

The difference Test (t-test) is used to determine the effect between before treatment (pretest) and after treatment (posttest). Posttest results between the experimental class and the control class was using a t-test to test the difference. Here are the statistical hypotheses in this study:

H_0: $t_{count} < t_{table}$ (there is no influence between learning model learning cycle 5e practice-based Critical Thinking Skills)

H_a: $t_{count} \geq t_{table}$ (there is an influence between learning model learning cycle 5e practicum-based Critical Thinking Skills)

RESULT AND DISCUSSION

Validity and reliability test

Validity test conducted in Class XII MIPA 4 totaling 35 students. The results of the validity test can be concluded that of the 20 questions, there are 12 valid questions. This means eight questions are invalid and will not be listed on the pretest and posttest sheets. Twelve valid questions represent each indicator of critical thinking skills.

Reliability test researchers did from the test results of the instrument data in Class XII MIPA 4, totaling 35 students. From the calculation of as many as 12 questions that have been validly obtained r_{11} value of 0.84 which is in the range of $0.60 < r_{11} \leq 0.80$, so the instrument's problem has a high reliability level.

Normality Test

The normality test was conducted in 2 classes, the experimental and control classes. In Tables 4 and 5, it can be concluded that all data are normally distributed.

Table 4 Normality test results on experiment class

Experiment class		
Type test	Pretest	Posttest
Confidence level	99.5%	99.5%
χ^2_{count}	10.26	3.71
χ^2_{table}	12.8	12.8
Conclusion	Normally Distributed Data	Normally Distributed Data

Table 5 Normality test results on the control class

Control class		
Type test	Pretest	Posttest
Confidence level	99.5%	99.5%
χ^2_{count}	7.23	10.6
χ^2_{table}	10.82	12.8
Conclusion	Normally Distributed Data	Normally Distributed Data

Homogeneity Test

The normality test was conducted in 2 classes, the experimental and control classes. In Table 6, it can be concluded that all data are homogeneous.

Table 6 Homogeneity test results

Type test	Pretest	Posttest
F_{count}	1.14	2.35
F_{table}	2.28	2.35
Conclusion	Homogeneous	Homogeneous

Difference Test (T-Test)

Researchers used posttest data, experimental class, and control class to conduct the T-test. In Table 7, there are data analysis results of different tests.

Table 7 Different test results (T-test) posttest experiment class and posttest control class

Data	n	Average
Experiment	35	52.37
Control	32	41.48
Confidence level	99.5%	
t_{count}	8.61	
t_{table}	2.657	

From Table 7, it is known that the t_{count} value is greater than the t_{table} value of 8.61>2.675 then at the level of confidence 99.5% H_a is accepted so that there is an influence of learning model learning cycle 5e based on practicum on critical thinking skills of students of Class XI science on mechanical. Below is a comparison of

pretest and posttest t-test results in experimental classes presented in Table 8.

Table 8 Different test results (T-test) pretest-posttest experiment class

Data	n	Average
Pretest	36	22.22
Posttest	35	52.37
Confidence level	99.5%	
t_{count}	26.52	
t_{table}	2.654	

From Table 8, it is known that the t_{count} value is greater than the t_{table} value of 26,52>2.654 then at the level of confidence 99.5% H_a is accepted so that there is an influence of learning model learning cycle 5e based on practicum on critical thinking skills of students of Class XI science on mechanical. Below is a comparison of pretest and posttest t-test results in the control class presented in Table 9.

Table 9 Different test results (T-test) pretest-posttest control class

Data	n	Average
Pretest	31	18.23
Posttest	32	41.84
Confidence level	99.5%	
t_{count}	15.95	
t_{table}	2.659	

From Table 9, it is known that the t_{count} value is greater than the t_{table} value of 15,95>2.659 then at the level of confidence 99.5% H_a is accepted so that there is an influence of learning model learning cycle 5e based on practicum on critical thinking skills of students of Class XI science on mechanical.

Average score Pretest-Posttest experimental class and control class

Average score pretest-posttest experimental class and control class are listed in Figure 1.

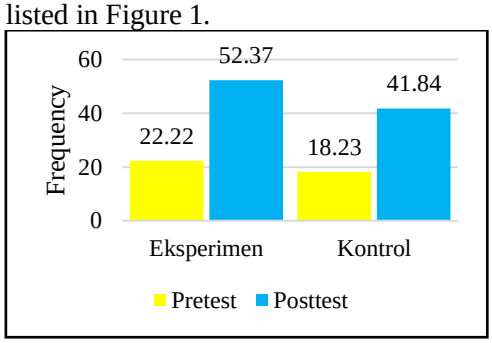


Figure 1 Average score pretest-posttest experimental class and control class

From Figure 1, it can be seen that the normal pretest score of the exploratory lesson is 22.22. Whereas the normal pretest score of the control lesson is 18.23. It appears that the pretest score of the test course is higher than that of the control lesson. The normal score of the test lesson posttest was 52.7 whereas the normal score of the control course posttest was 41.84. So from this information, it can be seen that the test course posttest score is higher than the control lesson.

The average score on each indicator of Critical Thinking Skills in the experimental class

Critical thinking skills have three aspects: basic clarification, basic decisions, and conclusions. Each of the three aspects has indicators. The following researchers present the average score of each indicator in the experimental class in Table 10.

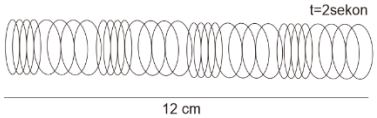
Table 10 The average score on each indicator of critical thinking skills in the experimental class

Indicator	Pretest	Posttest
Focus on question	2.83	4.44
Analyze arguments	2.31	4.08
Ask and answer clarification questions	1.19	3.99

Indicator	Pretest	Posttest
Understand and use elementary graphs and maths	2.00	4.39
Judge the credibility of a source	2.19	4.00
Observe judge observation reports	1.31	4.42
Use existing knowledge	3.19	4.33
Deduce and judge deductions	1.50	4.42
Make and judge inductive inferences and arguments	1.31	3.97
Make and judge value judgments	1.19	4.50

Table 9 shows that in each indicator, students experience an increase in critical thinking skills after being treated in the form of a learning cycle 5e learning model based on practicum on mechanical wave material. The largest increase occurred in the indicator of observing and assessing the observation report, which increased by 3.11. This can be seen from students' responses after being given a learning model learning cycle 5e. On this indicator, students were instructed to prove a fast propagation on longitudinal waves. Before students are given treatment in the form of a learning model learning cycle, 5e practicum-based students only guess the answer following the estimates. However, after the students were given treatment in the form of a learning cycle 5e model based on practicum, the students answered the problem with proof of calculation. The following is a detailed explanation.

Note the following Figure 2.



The Figure 2 is the result of practicum observations conducted by Cinthiya. Try to observe the results of Cinthiya's practicum. Is it true that the wave propagation speed is 0.06 m/s?

experimental class answers

Is known:

L= 12 cm= 0.12 m

t = 2 seconds

n = 4

Asked:

is it true that the wave propagation speed is 0.06 m/s?

Answer

$\lambda=L/n$

$\lambda=0.12/4=0.03$ m

$v=f\lambda$

$v=n/t\ \lambda$

$v=4/2\ 0.03$

v=0.06m/s

Cinthiya's opinion was correct

Control class answers

it looks like Chintya's answer is correct

The average score on each indicator of Critical Thinking Skills in the control Class

The average score of each indicator of critical thinking skills in the control class can be seen in the form of a diagram in Table 11.

Table 11 The average score on each indicator of Critical Thinking Skills in the control class

Indicator	Pretest	Posttest
Focus on question	1.47	4.44
Analyze arguments	1.28	4.31
Ask and answer clarification questions	0.74	3.2
Understand and use elementary graphs and maths	1.35	3.56
Judge the credibility of a source	1.64	3.56

Indicator	Pretest	Posttest
Observe judge observation reports	1.89	3.72
Use existing knowledge	1.58	3.34
Deduce and judge deductions	1.53	3.31
Make and judge inductive inferences and arguments	0.86	2.75
Make and judge value judgments	1.28	2.88

Table 11 shows that in each marker, understudies have moved forward basic considering abilities after being treated within the coordinate instruction learning show based on practicum on mechanical wave fabric. The largest increase occurred in the argument analysis indicator, as much as 3.03.

Learning shows that learning cycle 5E could be a demonstration employing a constructivist approach with stages so that understudies can play a dynamic part in learning exercises. In this demonstration, students have the opportunity to get their knowledge through the direction of the teacher. This learning Model is Piaget's intellectual development such as assimilation, accommodation, and organization that allows students to practice their critical thinking skills (Bormanaki, 2017; Kharida et al., 2009; Sulistyowati, 2019)

At the engagement stage, students are directed to focus on questions by asking questions such as “What happens to the wavelength if the propagation speed value gets bigger?" After being given a question, students are directed to answer by giving their arguments, or students ask back after answering the question (Fadillah et al., 2018). After that, at the exploration stage, students are directed to conduct a practicum. The purpose of the practicum is so that students can find their answers to questions at the engagement stage. According to Panggabean et al. (2017), exploration activities aim to build experiences and discuss concepts, processes, or skills. Practicum conducted by students is to conduct a simple experiment on wave propagation speed. Students were divided into five groups and then did an experiment on the rope and calculated the speed of the rope. At this stage, students are also directed to be able to assess the credibility of the source by doing a practicum and ensuring whether the answers given by students at the engagement stage are right or not (Fryer, 2019; Licorish, 2018; Sugianto et al., 2020). Students use student worksheets in practical activities. Student worksheet contains objectives, theoretical basis, tools and materials, how to work, tables of work results, data analysis, questions, and conclusions. This is in line with the opinion of Algiranto & Sulistiyono (2021) that students ' critical thinking skills can be trained in the exploration phase, namely at the beginning of the activity before the practicum begins, students are required to formulate problems, formulate hypotheses in student worksheet with guidance from teachers.

The third stage is an explanation; at this stage, students are directed to use their knowledge after doing a practicum at the exploration stage by presenting the practical results. According to (Nori et al., 2019), students are involved in exploration that has been done and explained at this stage. Furthermore, in the elaboration stage, students focused on observing and assessing observation reports. From the practical results that have been obtained, students find out again about the relationship of the material that has been studied with the phenomena in life (Betriza, 2018).

This is in line with the results of Velly (2018) that students can apply the concepts learned at the elaboration stage. Budi (2019) also expressed that the capacity to think can be raised within the

elaboration organized is to prepare understudies to apply caught-on concepts to a genuine circumstance. The last stage is evaluation; at this stage, students are focused on making and assessing conclusions by jointly making conclusions from the material studied and working on some practice questions. According to Yasni (2020), the learning process in the evaluation stage is the teacher evaluating the results of student activities during learning. Lina & Desnita (2022) also state that the critical thinking ability that can be raised in the evaluation stage is to make conclusions.

CONCLUSION

The learning model learning cycle 5e practicum-based critical thinking abilities of students have an impact on the content of mechanical waves. It can be inferred based on the study findings, data processing, hypothesis testing, and discussion that researchers have provided. Theoretically, the benefit of this study is to provide theoretical support on the implementation and impact of learning model learning cycle 5e-based practicum in learning critical thinking skills and physics learning. The benefit of this study practically for students is that students can practice critical thinking skills. Educators are expected to develop learning to determine the effect of learning model learning cycle 5e on critical thinking skills based on practicum. For other researchers, it is expected to be a reference on the effect of the practicum-based learning cycle 5e learning model on students ' critical thinking skills on mechanical wave material.

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