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Implementation of Differentiated Learning Using the Inquiry Based Learning (IBL) Learning Model to Improve Students' Critical Thinking Abilities

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Abstract
This study aims to determine the effect of differentiated learning process using the IBL learning model on improving students' critical thinking ability at each initial ability and to determine the differences in critical thinking ability that may be caused by initial abilities. The sample in this study were students of class X1 and X2 of SMAN 1 Sekampung in the 2024/2025 academic year. This research design uses One Group Pretest Posttest Design. The research instrument uses essay questions with critical thinking ability indicators. The results of this study indicate that there is a difference in the pretest and posttest scores of students where the posttest score is greater than the pretest score, thus it can be stated that there is an increase in students' critical thinking ability. In addition, the N-gain value obtained is greater than 0.05 which states that there is no difference in students' critical thinking ability based on the initial ability group.

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INTRODUCTION

Education plays an important role in advancing the nation, because education is a medium to develop the capabilities and progress of a dignified nation in order to educate the nation's life (Niyarci et al., 2022). 21st century education is a new challenge for the world of education. The world of education takes a very influential position to be responsible for facing these challenges. The 21st century requires students to develop superior abilities (Maulidia et al., 2023). Students as educational products are required to have eight core competencies in 21st century educational skills, namely communication skills, critical and creative thinking skills, inquiry/reasoning skills, interpersonal skills, multicultural /multilingual literacy, problem solving, information/digital literacy; and technological skills (Miharja, 2021).

Critical thinking ability are very important for students to have, because students who have critical thinking ability will be better prepared to solve problems and make decisions that will be accounted for in class (Ariyana, 2018). This makes critical thinking ability need to be improved. It is hoped that learning in the 21st century requires students to have high-level thinking ability, one of the highlevel thinking ability is critical thinking, in physics learning it is closely related to problem solving, in problem solving critical thinking ability are needed.

Critical thinking can be taught by teachers, teachers must guide and direct students to stimulate their critical thinking ability. However, in reality, critical thinking ability are still relatively low, according to research results, information was obtained that student scores based on critical thinking ability indicators in Medan had an average value of 59.57 (Adinda et al., 2022), in Ciamis Regency it was 49.35 (Mustajab el al., 2018), in Bandung only 46.60 (Wahyudi et., al 2020). Based on the data, the critical thinking ability of students in Indonesia need to be improved, better learning implementation is needed to improve students' critical thinking ability. One way to do this is to implement a learning process that can encourage students' critical thinking ability in physics learning.

The Inquiry Based Learning learning model can improve critical thinking ability (Pujani, 2022). The IBL learning model can improve critical thinking ability because at the learning activity stage, students must search for and find information independently (Lestari & Putri, 2019). However, there has been no research that focuses on differentiated learning that reviews students' initial learning abilities. The abilities possessed by students are included in learning readiness (Suhelma et al., 2021). A condition that shows the ability to follow the learning process is interpreted as readiness (Apsarini, 2020: 164). According to Tamlinson, CA et all. (2005) readiness is the knowledge, understanding and level of skills possessed by students on a topic. Students certainly have varying initial abilities. Therefore, it is important to examine whether IBL can improve critical thinking ability in differences in initial abilities. In addition, in implementing this research, it is unfair if the same treatment is given between students with low, medium,

and high initial abilities, so the application of differentiated learning is needed.

Every individual has differences between one another. Likewise, every student in the class must have different learning needs and readiness. To respond to this, teachers can open up different learning opportunities for students by implementing differentiated learning, teachers will help identify the diversity of their learning needs. Teachers can free students to learn, this is an effort to respond to their diversity and help improve their abilities according to the demands of 21st century education (Salamah, et al. 2023).

Based on an interview with one of the physics teachers at SMAN 1 Sekampung, it was found that teachers have not stimulated critical thinking ability and teachers have not used learning models on climate change material. Teachers have also not paid attention to students' learning needs during the learning process, especially related to initial abilities that indicate students' readiness to learn. Based on the description above, it is very important to know the implementation of differentiated learning using the IBL model can improve students' critical thinking ability according to students' initial abilities. So a study was conducted with the title "Implementation of differentiated learning using the inquiry based learning (IBL) learning model to improve students' critical thinking ability".

METHOD

The research method used is a quantitative method. The purpose of this study is to determine the effect of differentiated learning with the inquiry based learning model on students' critical thinking ability, as well as to determine the differences in critical thinking ability that may arise from initial abilities. The research design used in this study is One Group Pretest Posttest Design. The pretest was conducted before the treatment was given and the posttest was conducted after the treatment was given. This research design can be seen in Table 1.

Table 1. Research Design

Pretest	Treatment	Posttest
O1	X	O2

Description:
O1 : Pretest given before treatment is given.
O2 : Posttest given after treatment is given.
X : Differentiated learning treatment with IBL learning model

The sample in this study took two experimental classes, namely X1 and X2, which would later be given differentiated learning treatment with the IBL model.

The first research procedure carried out was initial observation, where the researcher conducted a preliminary study of interviews with physics teachers to find out about the initial conditions of class X students of SMAN 1 Sekampung. Second, the implementation of the research, this stage includes providing a pretest to determine the initial abilities of students, analyzing the results of the Pretest to and categorizing them into 3, namely low, medium, and high, grouping students according to their initial ability level, carrying out learning activities in the classroom by implementing differentiated learning processes according to the initial abilities of students using the IBL learning model, conducting a final test by providing a posttest to see the critical thinking ability of students. The final stage is to analyze the data that has been obtained and conclude the results of the study

The instrument used in this study was a test sheet. This test sheet was used during the pretest and posttest with 6 questions following the indicators of critical thinking skills according to Facione (2011), namely interpretation, analysis, inference, evaluation, explanation and self-regulation.

The data collection technique in this study was carried out by written tests. The written test is in the form of essay questions. The test is given before learning (pretest) and after learning (posttest).

The first data analysis technique in this study is the analysis of initial ability data. The pretest data was analyzed to group students based on their initial abilities. The pretest results were analyzed into 3 groups, namely low, medium and high initial ability groups. Next, n-gain data analysis was carried out, normality tests on the pretest posttest values for each initial ability and the n-gain normality test for each initial ability, the next analysis was the homogeneity test for pretest and posttest values and the homogeneity of ngain values. Hypothesis testing in this study used the Wilcoxon test and the oneway ANOVA test

RESULTS AND DISCUSSION

Results of the Difference Test of the Average Pretest and Posttest

1. Normality Test

Table 2. Normality Test Results Pretest Posttest Values

Parameter	Low		currently		High	
Asym. Sig. (2-tailed)	*Pretest*	*Posttest*	*Pretest*	*Posttest*	*Pretest*	*Posttest*
	0,000	0,148	0,002	0,193	0,000	0,000

Based on Table 2, the pretest values for low, medium and high initial abilities have a significance value of less than 0.05, and the posttest results for low and medium initial abilities have a significance value of more than 0.05, but the posttest values for high initial abilities have a significance value of less than 0.05, so H0 is rejected, meaning the data is not normally distributed.

2. Homogeneity test

Table 3. Homogeneity Test Results

	Levene Statistic	Df_1	Df_2	Sig.
Pretest	3,533	2	67	0,035
Posttest	5,217	2	67	0,008

Based on Table 3, the results of the homogeneity test of the Pretest and Posttest values are less than 0.05, meaning that the learning outcomes of the low, medium, and high initial ability groups do not have the same variance.

3. Wilxocon test

Table 4. Wilxocon test Result

	Test Statistics	
	Z	*Asymp. Sig. (2tailed)*
Pretest rendah - *Posttest* rendah	-3,827[b]	0,000
Pretest sedang - *Posttest* sedang	-5,027[b]	0,000
Pretest tinggi - *Posttest* tinggi	-3,742[b]	0,000

Based on Table 4 shows that the results of the Wilcoxon test Sig. (2-tailed) value on each initial ability is less than 0.05, then H0 is rejected and H1 is accepted, meaning that there is a significant increase between the average pretest and posttest. Therefore, it can be concluded that there is a significant increase in critical thinking skills on each initial ability after being given treatment.

Results of the Average Difference Test of N-gain between Students with Low, Medium, and High Initial Abilities.

1. N-Gain

Table 5. Critical Thinking N-gain Score Average Data

Initial ability	Score			
	N-gain highest	*N-gain* lowest	*Average* N-gain	*Std. Dev*
Low	0,93	0,36	0,6892	0,19
currently	0,91	0,20	0,5896	0,17
High	0,89	0,33	0,5871	0,19

Table 5 above shows the average N-gain value of students with low, medium and high initial abilities. The average N-gain value of low initial abilities is higher than that of medium and high initial abilities. However, the three initial abilities have an average N-gain value in the medium category.

2. ***N-Gain Normality Test***

Table 6. Results of the Normality Test of N-gain Values

Parameter	Initial Ability			Interpretasi
	Low	currently	High	
Asymp. Sig. (2-tailed)	0,200	0,200	0,152	Normal

Table 6 shows the results of the normality test of N-gain for low, medium, and high initial abilities. It has a significance value greater than 0.05, so H0 is accepted and H_1 is rejected, meaning that N-gain for low, medium, and high initial abilities is normally distributed.

3. ***Homogeneity Test of N-gain Values***

Table 7. Homogeneity Test Results of Ngain Values

Levene Statistic	Df1	Df2	Sig.
0,348	2	67	0,707

Based on Table 7, the results of the homogeneity test show that the N-gain value is more than 0.05, so H_0 is accepted and H_1 is rejected, meaning that the learning outcomes of the low, medium, and high initial ability groups have the same variance.

4. ***One Way Anova test***

Table 8. One Way Anova Test Results

Sum of Squares	Df	Mean Square	F	Sig.
0,126	2	0,063	1,867	0,162

Table 8 shows the results of the One Way Anova test which has a significance value of 0.162, this value is more than 0.05, so H0 is accepted and H1 is rejected, meaning there is no difference.

Discussion

Improving Critical Thinking Ability

This study was conducted to determine whether or not there was an increase in critical thinking Ability of students with low, medium, and high initial abilities when differentiated learning using the IBL learning model was applied. The results of the study can be seen from the Wilcoxon test using the average pretest and posttest values of each initial ability group. The results of the Wilcoxon hypothesis test for low initial abilities obtained a sig. 0.000, medium initial abilities sig. 0.000 and high initial abilities sig. 0.000. Each initial ability obtained a sig. <0.05. This means that there

is a significant increase in critical thinking Ability in each initial ability.

Improving students' critical thinking ability is one of the impacts of implementing the Inquiry-Based Learning (IBL) learning model guided by differentiated learning. In the IBL learning model, there are several phases that support the development of students' critical thinking ability. Indicators of critical thinking ability include interpretation, analysis, conclusion, evaluation, explanation, and selfregulation.

The orientation phase can support critical thinking ability of interpretation indicators. In this phase, students observe problems related to climate change in videos provided by the teacher to stimulate students' curiosity. Basically, students' interest in learning is low because the learning is considered boring. Learning that is delivered verbally will only provide an abstract picture (Maulana et al., 2022). Students must be shown a real form that can be seen directly so that it arouses their curiosity (Rahmawati & Ramadan, 2021). The orientation phase presented with videos helps students to form a strong foundation of knowledge, so that they can develop the basic ability needed for interpretation.

The problem-formulating phase can support critical thinking ability of analysis indicators. In this phase, students are faced with situations or questions that require indepth analysis. In addition, in this phase, there are puzzles that challenge students to think about how to solve them. The process of finding answers is an effort to develop their abilities through the thinking process (Setyorini., 2020). This problemformulating activity requires the ability to analyze information and formulate relevant questions. Thus, students are trained to think critically in dealing with problems.

The hypothesis formulation phase can support the critical thinking ability of the explanation indicator. The hypothesis formulation phase encourages students to develop conjectures or predictions. The ability to guess or commonly called hypothesizing, can serve as a foundation for achieving a more complex stage of thinking (Sanjani., 2019).

The data collection phase can improve critical thinking ability in analysis and conclusion indicators. The data collection phase encourages students to search for,

identify information from various sources and analyze the data to support the hypothesis of the formulated problem formulation (Indriyani et al., 2025). The learning process of students seeking information helps students to improve their skill competencies in the form of students' scientific thinking processes (Putri et al., 2019). This learning activity trains students' analytical skills by teaching them to develop skills to conclude.

The hypothesis testing phase can improve critical thinking ability in the evaluation and explanation indicators. The hypothesis testing phase encourages students to assess the validity of their hypotheses through analysis of the data that has been collected. Hypothesis testing learning activities direct students in making comparisons with the assumptions that students think before finding a solution to the problem (Lusyana & Silviani 2022). In addition, students are taught to evaluate evidence that supports or rejects their hypotheses. In this process, students also learn to explain the results of their hypothesis testing.

The conclusion-making phase can improve critical thinking ability in the conclusion and self-regulation indicators. This phase encourages students to integrate and critically evaluate their findings. In this phase, students are taught to draw logical conclusions based on the data that has been collected. In addition, students are also taught to evaluate the effectiveness of the strategies used during the learning process, as well as to identify areas that need improvement. This reflection process develops self-awareness and the ability to adjust their learning strategies. Thus, the conclusion-making phase in IBL can support critical thinking skills in the conclusion and self-regulation indicators. In line with the opinion of Hani'ah & Fadly, (2023) which states that making conclusions in the IBL model develops the ability to make conclusions.

Through a series of phases, students are able to improve their critical thinking ability. This statement is supported by the results of research conducted by (Pujani, 2022; Putri et al., 2023; Indriyani et al., 2025) which states that the IBL model influences students' critical thinking skills. The IBL model requires students to play an active role in investigating existing problems.

Effects of Differentiated Learning

This study aims to determine whether differentiated learning using the IBL learning model can reduce the difference in increasing critical thinking ability between students with low, medium, and high initial abilities. The following are the results of the N-gain analysis regarding whether or not there is a difference in increasing critical thinking ability in the low, medium, and high initial ability groups. The results of the N-gain analysis of the bar chart are presented in Figure 1.

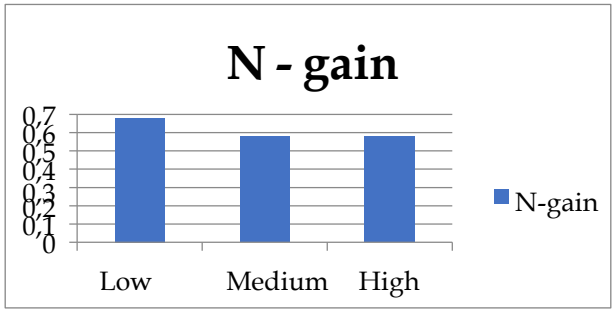

Figure 2. N-gain bar chart of each initial ability group.

Based on the results of the N-gain analysis of the graph presented in Figure 3 regarding whether or not there is a difference in the increase in critical thinking ability in the low, medium, and high initial ability groups. The analysis of the N-gain value is that the low initial ability group has a value of 0.689, the medium initial ability is 0.589, and the high initial ability is 0.587. The results of the One Way Anova test using the N-gain value obtained a significance value of 0.162. This shows that there is no difference in the N-gain of critical thinking of students caused by differences in initial abilities.

Learning activities of students with low initial abilities receive full guidance from the teacher. At each phase of the LKPD, instructions and examples of work are provided. In addition, their LKPD is also equipped with reliable sources to search for and collect data. The time to complete the LKPD for students with low initial abilities is different from students with high initial abilities. Full guidance is carried out as an effort to improve students' critical thinking ability because students with low initial abilities usually make more mistakes. (Damayanti et al., 2021). The teacher directs and guides them at each phase of learning. This statement is supported by the results of research conducted by Ardianto et al., (2023) which states that teacher guidance has an effect on student learning achievement. Wibowo & Farnisa (2018) also stated that there is a relationship between the role of teachers in the learning process

and student learning achievement. In addition, the results of research conducted by Dewi & Yuniarsih (2020) stated that the role of teachers has a significant positive effect on student learning motivation.

Students with moderate initial abilities also receive teacher guidance, but only a little guidance, they are given the opportunity to learn independently. At each phase of the LKPD, students are provided with clues. However, LKPD is not equipped with examples of work. Their LKPD is also equipped with reliable sources to search for and collect data. In addition, students with moderate initial abilities are also given different times compared to students with high initial abilities. During learning activities, students with moderate abilities will experience a learning process that is in accordance with their abilities. So that it helps students with moderate abilities to continue to develop and improve their critical thinking ability. Learning that is differentiated based on the differences in student abilities in class helps students prepare themselves better (Isrotun., 2022).

High-ability student groups are given guidance only when they find it difficult, they are required to be independent in learning activities in each phase. Only in phases 1 and 2 of the student's LKPD are provided with clues. They are also required to find reliable sources to collect data. In addition, students with high abilities are required to be faster in completing each phase of learning. During learning activities, students who have high initial abilities will experience a more independent learning process, develop analytical and critical ability, and improve their critical thinking ability. In line with the opinion of Salamah, et al. (2023) which states that learning activities that are in accordance with students' abilities make them confident in carrying out learning activities so as to improve their abilities.

The active response of students during the learning process shows that learning is going well, which makes it easier for students to understand the material because it is in accordance with their abilities. Supported by research conducted by Marlina & Aini (2024) which states that grouping students based on learning readiness affects their average learning outcomes.

Differentiated learning has been proven effective in improving students' critical

thinking ability, even though there are differences in initial abilities that indicate learning readiness between them. This statement is supported by the results of research conducted by Wahyudi et al. (2023), which concluded that the application of differentiated learning can address the diversity of student needs.

CONCLUSION

Differentiated learning using the IBL learning model can significantly improve critical thinking ability in each initial ability with a moderate N-gain. Differentiated learning using the IBL learning model can reduce differences in improving critical thinking skills that may be caused by differences in initial abilities.

Previous research results also show that differentiated learning has an effect on students' critical thinking ability (Avandra & Desyandri, 2023; Muhlisah et al., 2023; Minangkabau et al., 2024), but none have specifically reviewed students' initial abilities. Therefore, the difference in this study is using differentiated learning with the IBL model to improve students' critical thinking ability based on initial abilities.

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