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How Critical Thinking Skills Influence Misconception in Electric Field

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Abstract: This study aimed to determine the influence of critical thinking skills on misconceptions using a five-tier instrument in mixed-method research. The sampling technique used is simple random sampling. The data collection instrument used a critical thinking skills questionnaire, a misconception test of electric field material, and interviews. Data collection begins with quantitative data, providing a misconception test sheet and a critical thinking skills questionnaire. After that, the researcher took qualitative data in the form of interviews to strengthen data that had been obtained previously. Then from the results of the regression coefficients, there is an influence of critical thinking skills on misconceptions. The descriptive results of critical thinking skills data show that the mean of critical thinking skills is 68.50, which means that students' critical thinking skills are in a good category. Then from the results of the regression coefficients, there is an effect of critical thinking skills on a misconception, with the probability number obtained being significant. The limitations of this study are only to identify and see the impact.

Keywords: *Critical thinking skills, electric field, misconception, physics learning.*

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Introduction

Physics learning is a branch of natural science that includes facts, concepts, principles, laws, and everyday life (Sugiarti & Ratnanigdyah, 2021; Suliyanah et al., 2020); Sugiarti & Ratnanigdyah, 2021; Suliyanah et al., 2020). In this physics learning, students are more active in seeking, investigating, and developing so that students can gain mastery of concepts that are meaningful and deep (Astra et al., 2020; Sopiany & Rahayu, 2019; Widyaningsih et al., 2020). Students do not just remember what they have learned in learning physics, but they must have the correct conception (Dewi et al., 2021; Didik & Aulia, 2019; Meilani, 2016; Nur et al., 2016). The conceptions held by students are difficult to change because these conceptions have deviated from the conceptions put forward by experts (Halim et al., 2019; Kaltakci-Gurel et al., 2017; Triman et al., 2021). This deviation is called a misconception. Students' difficulty understanding a concept can lead to misconceptions (Jayadi et al., 2020; Manunure et al., 2020). The misconceptions experienced by students are usually caused by the provision of initial concepts or incomplete facts from the teacher, so that students, when receiving the idea, experience confusion or this misconception can also occur because of the students themselves (Nur'aini et al., 2020; Octavia et al., 2021; Safriana & Irfan, 2021). It can happen due to the lack of students' analytical skills. This analytical ability is needed because physics learning influences one another. Thus, it is necessary to identify misconceptions. One form of identification of misconceptions is giving students a diagnostic test. This diagnostic test is a solution to finding student misunderstandings. Many diagnostic tests have four tier (Khandagale & Chavan, 2017; Putra et al., 2020; Qonita et al., 2020). This study uses a five-tier diagnostic test instrument for electric field materials.

The five-tier diagnostic test is a 5-level test (Dirman et al., 2022; Qonita et al., 2020), which consists of the first level is a multiple choice question (Arslan et al., 2012; Caleon, 2010; Yusrizal & Halim, 2017). The second level is the confidence in the answers on the first level (Liu & Fang, 2021; Taslidere, 2016; Yusrizal & Halim, 2017). The third level is the reason for answering questions. The fourth level is the confidence in reason of answers. Fifth, the information obtained by students to answer the questions in questionnaire (Kaltakci-Gurel et al., 2017; Maison et al., 2019; Taslidere, 2016).

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With this diagnostic test, it is easier for teachers to reduce the occurrence of misconceptions and can see the sources of information obtained by students on electric field material.

Electricity is one of the physics subject matter that students have misconceptions about because this material is related to everyday life. Since electricity is widespread in everyday life, it is natural for students to have misconceptions about electricity. Although almost all books discuss electric fields, students do not clearly understand the electric concept (Başer & Geban, 2007). Another misunderstanding in students is about electric charge, namely that charged objects only contain electrons or protons (Eryilmaz et al., 2015). Most students do not have a clear understanding of the concept of an electric field; therefore, misunderstandings occur. For example, students have difficulty understanding electric field lines. According to the student, electric field lines are real, but in actual concept, electric field lines are the locus of points whose direction of field strength is the same as the line (Kaltakci-Gurel et al., 2017). Based on research conducted by (Setyaningsih et al., 2018), it is stated that 96.97% of twelfth-grade students experience misconceptions about electric field material. In addition, 0% understand the concept, and 6.06% do not understand the concept. Many students experience misconceptions about an electric field because electricity learning includes sub-materials, namely electric force, electric field, electric charge, static electricity, and dynamic electricity. In the learning process, skills are needed.

One of the skills needed in learning is critical thinking skills (Ariani, 2020; Mason, 2007; Zain & Jumadi, 2018). Critical thinking skills can analyze and evaluate information (Maknun, 2020; Purawati et al., 2016; Setiya Rini et al., 2020; Spector & Ma, 2019). In education, critical thinking skills are a top priority to achieve the learning objectives that have been set (Diani et al., 2019; Gunawan et al., 2019; Hasnawati et al., 2021; Muhammadiyeva et al., 2020). With critical thinking skills, students can understand and analyze problems well to achieve learning objectives (Darmaji et al., 2020). It is difficult for teachers to cultivate students' critical thinking skills if they are unaware of critical thinking and how to cultivate it in classroom practice (Jatmiko et al., 2018; Leasa et al., 2020; Putri & Istiyono, 2017).

Several studies have been carried out previously related to the research to be carried out. As for the results, Sahin (2010) explains problem-based learning about physics beliefs and conceptual understanding of energy and momentum. Next, Abrahams et al. (2015) describe the prevalence and nature of misunderstandings in physics. Further research by Steinberg et al. (2014) explains the persistent misunderstanding of Newton's matter. Apart from Indonesia, many countries research misconceptions in physics. A study conducted by Métioui and Trudel (2021) explained that students' misconceptions in Canada on heat and temperature were carried out using a two-tier diagnostic test format. Research conducted by Wangchuk and Penjor (2020) explained that students in Bhutan have misconceptions about light material, and one way to reduce misconceptions in Bhutan is to study in groups. Then the research carried out by Şenyiğit (2021) explained that in Turkey, misconceptions can be reduced by using the PBL model on the electrical circuit material. Research conducted by Susanti et al. (2021) explains the misconception analysis and strategic thinking skills of students on parabolic motion material using two-tier multiple-choice instruments. His research is to develop a test instrument in the form of two-tier multiple-choice questions that can be used to analyze students' misconceptions and measure students' strategic thinking skills. Then research by Haryono and Aini (2020) diagnoses misconceptions about the heat concept using the three-tier test; The research was conducted to discover misconceptions using a three-level test on heat material to reduce misconceptions. A study conducted by Maison et al. (2019) identified misconceptions on temperature and heat topics using a four-level diagnostic instrument.

The research conducted by Okolie et al. (2021) explains improving students' critical thinking skills through involvement in classroom learning. This means that students are more active in this study to ask, seek, find, and seek solutions. Further research by Noordink and Naidu (2014) describes instruction analysis for critical thinking in distance learning. Then the study conducted by Espey (2017) explained that improving students' critical thinking skills can be done with team-based learning. The research was conducted to form teamwork in solving problems so that students' critical thinking skills can be formed properly. Then the research conducted by DuBois et al. (2019) describes strategies to encourage social interaction and critical thinking.

Critical thinking skills can affect the occurrence of misconceptions; this can positively or negatively influence students. The influence on misconceptions is significant if critical thinking skills are low; on the contrary, if misconceptions are low, critical thinking skills are high Missa et al. (2020). When students experience misconceptions, they lack analysis and lack problem-solving skills, which causes students' critical thinking skills to be low. This is usually due to the lack of student engagement in the classroom learning process. Students who often join in student-centered learning, of course, can analyze and be able to solve problems well. Critical thinking skills can solve problems, consider making decisions, and reduce the occurrence of misconceptions about electric field materials (Jolley et al. (2020). This study aimed to determine the effect of critical thinking skills on misconceptions using the Five-Tier Test instrument. The urgency reinforces this study to see the impact of critical thinking skills on misconceptions using the Five-Tier Test instrument. Researchers can see the effect and can identify the occurrence of student misconceptions about the electric field material. The questions in this study, namely:

1. What is the description of students' misconceptions about the electric field material and student critical thinking skills?

2. What is the influence of critical thinking skills on students' misconceptions in the electric field?

Methodology

Research Design

The research method used in this study is a mixed-method that combines quantitative and qualitative research (Ashari et al., 2016). The research design used is a sequential explanatory design. This design prioritizes quantitative methods, which will be a source of measurable and detailed data, after which qualitative data is used to strengthen the results of existing quantitative data (Rahma et al., 2016). Quantitative research uses statistical analysis in the form of numbers (Sujito & Pebriana, 2018). Quantitative research also explains explanatory, where this explanatory research aims to see the effect between the independent and dependent variables (Purba & Simanjuntak, 2011). While qualitative research is descriptive research, the analysis uses an inductive approach and is based on facts in the field (Pujayanto et al., 2018). In this study, the first data taken was quantitative data by distributing critical thinking skills questionnaires and a test of misconceptions about electric field material. Then proceed with qualitative data collection, namely by conducting interviews. Interviews were conducted to strengthen the quantitative data obtained by providing a misconception test sheet and a critical thinking skills questionnaire. In a study, sampling is very concerned.

Sample and Data Collection

The sampling technique in this study used a simple random sampling technique. The random sampling technique is taking samples randomly from the population so that each member of the population has the same opportunity to be taken as a research sample (Arieska & Herdiani, 2018; Osborn et al., 2017). The population used in this study was the twelfth-grade science student at SMA Negeri 8 Jambi City, as many as 125 students. The sample used in this study was 30 students taken randomly, taking 25%. In this study, the instruments used were very careful.

The data collection instruments used in this study were questionnaires, tests, and interview sheets. The test used is the Misconception Test. The misconception test in this study was in the format of a five-tier diagnostic test on the electric field topic. This five-tier instrument is used to discover misconceptions and information or sources obtained by students to answer Tier 1 and Tier 3 questions. This is so that teachers can find out information obtained by students to answer the questions provided. Educators will analyze sources of information received by students to find out where the error results in misconceptions in students (Rosita et al., 2020). The problem of misconceptions in the Electric Field material adopted from Afrianita (2021), with a five-tier format that has passed the validity and reliability test. Then the questionnaire used was a Critical Thinking Skills questionnaire, then an interview was conducted. The lattice of misconceptions in the Five-Tier format of the Electric Field material can be seen in Table 1.

Table 1. Grid of Misconceptions of Electric Field Matter

Sub Material	Draft	Question Item Number
Electric field	The greater the distance between the two charges, the weaker the electric force	1
	The force experienced by the two charges is equal but always opposite	2
	An object with a greater charge does not apply a greater force	3
	Every charged particle will move in an electric field	4
	Positively charged particles will move in the direction of the electric field, while negatively charged particles will move in the opposite direction to the electric field.	5
	The closer the lines of electric force, the greater the electric field of the two charges.	6
Total		6

From the lattice of the electric field material misconceptions, six items consist of 6 indicators. The instrument used in this study was in the format of the Five-Tier Diagnostic Test. It explains the students' answers, namely students who understand concepts, do not understand concepts and misconceptions. This five-tier answer category was adopted from (Nur'aini et al., 2020). The five-tier answer categories can be seen in Table 2.

Table 2. Five-Tier Test Answer Category

First level	Second level	Third level	Fourth level	Fifth level	Category
Correct	Sure	Correct	Sure	Teacher	Understand the concept
Correct	Sure	Wrong	Sure	Friends of the same age	Misconception (false positive)
Wrong	Sure	Correct	Sure	Internet	Misconception (false negative)
Correct	Sure	Correct	Not sure	Internet	Guessing, lack of confidence
Correct	Not sure	Wrong	Not sure	Book	Don't understand the concept
Wrong	Certain	Wrong	Sure	Internet	Misconception
Wrong	Certain	Correct	Not sure	Book	Don't understand the concept

The critical thinking skills questionnaire (Gupita, 2016) developed consists of 20 statement items divided into six indicators. The critical thinking skills questionnaire grid can be seen in Table 3 below.

Table 3. Grid of Critical thinking skills

No	Critical Thinking Skills Indicator	Statement Items		Amount
		Favorite	Unfavorable	
1	Analyze arguments	5.6	11, 14	4
2	Able to ask	1	3	2
3	Able to answer questions	4	8	2
4	Solve the problem	2,7,17	10, 15, 9	6
5	Making conclusions	12	13	2
6	Skills to evaluate and assess the results of observations.	19.18	16, 20	4
Total				20

The scale used in the critical thinking skills questionnaire is a Likert scale with five scales. Strongly Agree was given a score of 5, Agree was given a score of 4, Doubtful was given a score of 3, Disagree was given a score of 2, and Strongly Disagree was given a score of 1. The categories of students' critical thinking skills can be seen in Table 4.

Table 4. Category of assessment of students' critical thinking

No.	Conversion of Critical Thinking Skills Score	Category
1	0-45	Very bad
2	46-50	Bad
3	51-65	Neutral
4	66-75	Good
5	76-100	Very good

The category of misconceptions comes from Minarni et al. (2018), which can be seen in Table 5.

Table 5. Category Misconception

Misconception Interval	Category
0 – 30	Low
30 – 70	Medium
70 – 100	High

From the above categories, it can be seen that the percentage of 0-30 is categorized as low misconceptions experienced by students, 30-70 moderate misconceptions experienced by students, and 70-100 high misconceptions experienced by students.

Data collection in this study begins by giving a misconception test question in the format Five-Tier Test on the electric field material for students to fill in. After that, the critical thinking skills questionnaire related to the misconceptions was distributed again to obtain data according to the researcher's needs. After that, interviews were conducted to strengthen the questionnaire data and misconception tests. The data collection diagram is in Figure 1.

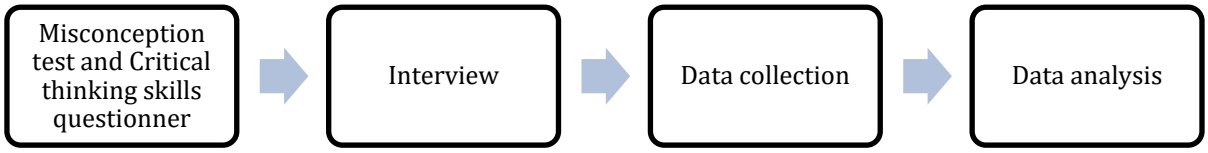

Figure 1. Data Collection Diagram

Analyzing of Data

The data obtained in this study are in the form of quantitative data and qualitative data. Data analysis used on quantitative data is descriptive and inferential statistical analysis. Descriptive statistics explain the state of the data consisting of frequency, mean, median, mode, maximum and minimum values (Amrhein et al., 2019; Tanti et al., 2021). Next, the inferential analysis was carried out using a linear regression test. Before the regression analysis is carried out, it is necessary to test the assumptions that must be made first. Assumption tests include normality and linearity tests (Zein et al., 2019).

A normality test is a test used to see whether the residual value is normally distributed or not. The normality test of the data can be said to be normal if the significance value is > 0.05, then the value is normally distributed. The linearity test was then carried out to determine whether the independent variable (X) and the dependent variable (Y) had a linear relationship. The linearity test of the data can be said to be linear by comparing the significance value, namely the significance > 0.05, or by comparing the calculated F value with the F table. After that, a regression test was performed to determine the effect of an independent variable (X) on the variable (Y). decision making in the regression test by looking at the significance value <0.05, then it can be seen in the magnitude of the influence of the R Square value (Gu, 2016; Pandey et al., 2017; Suo et al., 2017; Yuhelmi et al., 2018). All tests were carried out using the statistical product and service solutions (SPSS) application. The SPSS used in this research is version 23. Then qualitative data is analyzed using Miles and Huberman analysis, wherein this analysis, interview data is collected, then reduced, displayed, then conclusions are made from the existing data.

Findings / Results

After collecting data, then descriptive analysis was carried out on the data of misconceptions and critical thinking skills. The descriptive analysis of the misconceptions about the Electric Field material can be seen in Table 6.

Table 6. Descriptive statistics of misconceptions about electric fields

Interval	Category	Mean	Me	Mo	Max	Min
0 – 30	Low					
30 – 70	Currently	3.00				
70 – 100	High		3.50	3.00	6.00	1.00

Based on table 6, the descriptive statistical results of students' misconceptions about the magnetic field material are obtained. The mean is 3.00, the median is 3.50, the mode is 3.00, and the minimum-maximum value is 6 and 1. The descriptive statistical analysis of critical thinking skills data can be seen in Table 7.

Table 7. Descriptive Statistics of Critical Thinking Skills

Interval	Category	mean	Me	Mo	Max	Min
0-45	Very bad					
46-50	Bad					
51-65	Neutral					
66-75	Good	68.50	61.00	58	90	41
76-100	Very good					

Based on Table 7, the results of descriptive statistics of students' critical thinking skills are obtained where the results of the analysis are in the form of a mean of 68.50, which falls into the good category, the median result of 61.00, the mode of 58, and the maximum value is 90 and the minimum is 41. The normality of the results of misconceptions and students' critical thinking skills can be seen in Table 8.

Table 8. Tests of Normality

	Kolmogorov-Smirnova		
	Sig.	**Df**	**Distribute**
Electric Field Misconception	.200	30	Normal
	.200	30	Normal

Based on table 8, the normality test results of misconceptions on the electric field material and critical thinking skills are 0.200 and 0.200, which means that the data is normally distributed because the data requirements are normally distributed, and the significance value is greater than 0.05 (Spector & Ma, 2019). As for seeing the linearity of the data, a linearity test was carried out, which can be seen in Table 9.

Table 9. Linearity Test Results

			Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Critical thinking skills * misconceptions	between Groups	(Combined)	59,700	21	2.843	6.203	.008
		linearity	32.097	1	32.097	70,029	.000
		Deviation from Linearity	27,603	20	1,380	3.011	.000
		Within Groups	3,667	8	.458		
		Total	63,367	29			

Based on Table 9, it can be seen that the linearity significance value of critical thinking skills and students' misconceptions is 0.000, which means that the data is linear where the requirements of the linearity test have a significance value of 0.05. So the data is linear (Rahmatih et al., 2020). The regression test results to see the effect of critical thinking skills on students' misconceptions can be seen from the R Square of 0.510. It can represent the effect of critical thinking skills on misconceptions having an effect of 50%. The results of the ANOVA test can be seen in table 10.

Table 10. ANOVA Test Results for Critical Thinking Skills Against the Misconceptions of Electric Field Materials

Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	2419,639	1	1	29,840	.001b
	Residual	2357,328	28	28		
	Total	4776,967	29			

Based on table 10. The results of ANOVA on critical thinking skills on the misconception of electric field material can be seen = 29,840 with a significance level of 0.001.

This ANOVA test was used to compare the mean of the two groups. ANOVA is a comparative analysis of variance. The regression test to see the effect is in table 11 below.

Table 11. The Results of the Regression coefficient of Misconceptions and Critical Thinking Skills in the Electric Field

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	37,666	5.378		6.813	.000
	misconception	6.179	1.153	.712	5.361	.000

Based on table 11. The regression equation can be obtained using the general equation Y=a, where Y is the influencing constant variable. With the obtained power Y = 37,666+bX+ 6.179X.

Qualitative data were conducted through interviews on Monday, January 24, 2022, to strengthen students' answers. The interview system is a closed interview conducted by students. Based on statement 1, which describes students' responses to question number 2, when students answer question number 2, the force experienced by particle A is greater than the force experienced by particle B. From the answers to these reasons, student 1 has a misconception.

Based on statement 2, which describes the student's answer to question number 8, when students answer the statement of reason number 8 that at the same position, the acceleration of gravity of heavier objects will fall first compared to lighter objects. Based on the results of interviews that have been conducted with students, there are still some students who experience misconceptions; this is usually due to a lack of critical thinking skills and can be caused by the teacher.

Discussion

From the descriptive results of the misconceptions data, it is found that the mean of students' misconceptions is 3.00, which means that students' misconceptions are still relatively low. The median obtained is 3.50, where the median shows the data distribution, which means that there are not too many students who experience misconceptions with this median. The mode obtained is 3, which shows that most students have misconceptions about three questions. The minimum data result obtained 1, where the scatter of data shows the smallest. The maximum data result obtained 6, where the maximum data result from any data is large. The explanation above found that the five-tier test instrument saw students get information to answer a questionnaire on misconceptions from various sources, namely textbooks, teachers, the internet, and peers. Students who experience misconceptions mostly get their sources from the internet. Therefore, students cannot immediately accept what they read but must understand what they are reading from the internet, especially electric field material, which is still abstract.

From the descriptive results of critical thinking skills data, it is found that the mean of critical thinking skills is 68.50, which means that students' critical thinking skills are in a good category. The median obtained is 61.00, which shows the data distribution, which means many students have critical thinking skills. The minimum and maximum data obtained are 41, which shows the smallest and largest data distribution. Students who have good critical thinking skills, meaning that they can analyze and understand questions.

The regression coefficient shows an influence between critical thinking skills on misconceptions, which can be seen from the significance/probability level of 0.001 < 0.05. If the probability > 0.05, then Ho is accepted, but Ha is rejected (not significant). However, if the probability is < 0.05, Ho is rejected, but Ha is accepted, which means that the probability number obtained is significant (Ernst & Monroe, 2007; Rahmatih et al., 2020). Thus, it turns out that there is an influence of critical thinking skills on misconceptions. The influence of critical thinking skills can be seen in classroom learning, where if the teacher explains that it is still teacher-centered, students will not understand what they are learning. Nevertheless, suppose the teacher teaches students to look for and explore the information they need. In that case, this can build students' critical thinking skills so that misconceptions can be reduced, especially in electric field material. If misconceptions are high, critical thinking skills are low; on the other hand, if critical thinking skills are high, the misconceptions experienced by students are low (Gal-Ezer & Trakhtenbrot, 2016; Kizilcik et al., 2015; Türkmen & Usta, 2016). When critical thinking skills are high, it means that students have understood and can analyze the questions that have been given. Therefore, critical thinking is essential to check the truth of information to decide whether the information is acceptable and to work on the questions given by educators.

From the results of initial observations that have been made at the State High School 8 Jambi City, there are still students who are still experiencing misconceptions about the electric field; it is proven when the teacher asks questions about the concept of the electric field. On average, students can answer the questions that the teacher has given. According to the teacher, it is just that the answers given by students are still categorized as misconceptions. This proves that the electric field is a basic physics material that still experiences many misconceptions. The electric field material that is difficult for students to understand is electric force, electric field strength, electric charge, and lines of electric force. From the results of interviews conducted with students, it was found that students still had difficulty understanding the electric field material; this was because when the teacher taught the class, it was still teacher-centered but not student-centered. This causes frequent misconceptions and a lack of students' critical thinking skills in problem-solving (Bailin et al., 1999).

The research that has been done by Maharani et al. (2019) the research he did was carried out a four-level diagnostic test on Newton's law material. By using this four-level diagnostic test, the teacher can reduce the occurrence of misconceptions. Research conducted by (King, 2010) regards the analysis of misconceptions in science textbooks. In this study, the teacher can reduce the occurrence of misconceptions by giving students explanations and books that make students understand their lessons, especially on electric field material. Research conducted by Widiyatmoko and Shimizu (2018) found the factors that cause misunderstandings in the material of Light and Optics using diagnostic instruments. The existence of a diagnostic test instrument can reduce the occurrence of misconceptions on the subject of light and optics. Research conducted by Marhadi et al. (2019) examined the study of magnetic field misconceptions using the Four-Tier Test method. By using the four-tier instrument, the teacher can reduce the occurrence of misconceptions, especially on the subject of the magnetic field. Apart from Indonesia, many countries research misconceptions in physics. Métioui and Trudel's (2021) research explains that students' misconceptions in Canada on heat and temperature are carried out using a two-tier diagnostic test format. Research conducted by Wangchuk and Penjor (2020) explains that students in Bhutan experience misconceptions about light material, and one way to reduce misconceptions in Bhutan is to study in groups.

Karakoc (2016) researched the analysis of critical thinking skills in terms of physics education. This research was conducted in the educational process to improve students' critical thinking skills in learning physics. Then Negoro et al. (2018) study an effort to build critical thinking skills to reduce misconceptions using concept maps. By using a concept map, the teacher can improve students' critical thinking skills and can reduce the occurrence of misconceptions. Further research conducted by Batlolona et al. (2018) explains critical thinking skills using inquiry. With this research,

teachers can improve the higher-order thinking skills (HOTS) in students. Then the research carried out by Bensley and Lilienfeld (2017), explaining critical thinking skills can reduce misunderstandings in physics learning, especially in electric field material. Research conducted by Leasa et al. (2020) regarding research that explains improving critical thinking skills using Inquiry-Discovery through empirical.

In the research conducted to identify this misconception, there is a novelty. This novelty can be seen from the analysis of the influence of critical thinking skills on the level of students' conceptual understanding using a five-tier instrument to identify students' misconceptions on electric field material. The analysis of misconceptions using this five-tier instrument can make it easier for teachers to identify and improve students' critical thinking skills to reduce the occurrence of misconceptions (Jolley et al., 2020; Yilmaz et al., 2018). Furthermore, no research analyzes the effect of critical thinking skills on the level of conceptual understanding or on reducing students' misconceptions about electric field material at school. This novelty can improve the previous research conducted by Liu and Fang (2021) about analyzing misconceptions in the four-tier format on electric magnet material. In their study, they did not know the information obtained by students to answer misconceptions in the four-tier test format and had not seen the influence of critical thinking skills in reducing the occurrence of misconceptions. Therefore, it is necessary to analyze the effect of critical thinking skills on misconceptions about electric field materials at school.

The implication of this research is to identify students' misconceptions by analyzing the level of confidence in students' answers in answering the five-tier diagnostic test instrument in the second and fourth tiers. The causes of misconceptions are identified from the students' choices in answering the reasons for the third tier and the information students get in answering the questions in the fifth tier. Based on students' critical thinking skills towards mastery of concepts in electric field material, it is known that the cause of student misconceptions is due to the lack of students analyzing conceptual problems in electric field material, especially analyzing electric forces, electric field strengths, electric charges, and lines of electric force. Therefore, this research impacts how to overcome students' misconceptions, especially on the electric field material, by improving students' critical thinking skills regarding the misconceptions of electric field material. So that the objectives of learning physics, especially electric field material, according to the concept can be achieved. This follows Pujayanto et al. (2018) statement that the causes of misconceptions can come from conception, wrong intuition, associative and humanistic thinking, incomplete reasoning, student abilities, and interest in learning.

Therefore, based on the objectives of learning physics, the misconceptions experienced by students must be remediated so that students can solve problems related to physics concepts in everyday life. In addition, it is also necessary to analyze the causes of student misconceptions to make it easier to find the methods used to remediate these misconceptions. Therefore, it is essential to conduct more in-depth research on students' misconceptions because one of the causes of students experiencing difficulties in understanding physics is misconceptions.

Conclusion

From this study, it was found that the descriptive value of misconceptions was still classified as moderate. The descriptive value of critical thinking skills is in a good category. Then seen from the value of the regression coefficient shows that there is an influence between critical thinking skills on misconceptions. The increase in critical thinking skills can cause misconceptions in students to decrease. So the novelty of this research can be seen from the analysis of the effect of critical thinking skills on students' conceptual understanding levels using a five-tier instrument to identify students' misconceptions about electrical material.

Recommendations

The analysis of the effect of critical thinking skills on misconceptions in the five-tier test format is only limited to identifying and knowing the information obtained by students to answer questions and the impact of critical thinking skills on misconceptions in the electric field material. We already know that physics material in education is comprehensive, so it is not only limited to electric field material. This research is recommended for lecturers or teachers to understand or identify misconceptions that occur in students so that teachers can improve the learning process in the classroom and outside the classroom. For this reason, future research needs to identify misconceptions not only in electric field materials but in other physical materials.

Limitations

This study only identified misconceptions and their sources using a five-level instrument. Although critical thinking skills are affected by misconceptions, there are not yet complete instructions on how to remediate or anticipate these misconceptions. The second limitation is that the conceptions studied are only about the electric field, a small part of the electrical material.

Authorship Contribution Statement

Maison: Concept and design, final approval. Hidayat: Critical revision of manuscript, supervision. Kurniawan: Statistical analysis, reviewing. Yolviansyah: Writing. Sandra: Editing. Iqbal: Data acquisition

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