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Students' Misconceptions: Viewed from Students' Perceptions on Magnetic Field Learning

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ABSTRAK

Miskonsepsi adalah kesalahan dalam menghubungkan konsep yang mengakibatkan pemahaman ide dan konsep baru dalam pikiran siswa menjadi konsep yang salah. Penelitian ini bertujuan untuk menganalisis pengaruh keterampilan berpikir kritis terhadap miskonsepsi materi medan magnet. Metode penelitian yang digunakan dalam penelitian ini adalah metode campuran. Dalam penelitian ini, teknik pengambilan sampel yang digunakan adalah teknik simple random sampling untuk mengambil sampel dari populasi. Sampel yang digunakan adalah 30 siswa yang diambil secara acak melalui undian, sehingga diperoleh 30 siswa sebagai sampel. Instrumen pengumpulan data yang digunakan dalam penelitian ini adalah lembar wawancara dan angket. Desain penelitian yang digunakan adalah sekuensial explanatory design. Dari hasil deskriptif data miskonsepsi diperoleh rerata miskonsepsi siswa sebesar 3,59 yang berarti miskonsepsi siswa masih tergolong rendah. Hasil deskriptif data keterampilan berpikir kritis menunjukkan bahwa rerata keterampilan berpikir kritis adalah 64,03 yang berarti kemampuan berpikir kritis siswa berada pada kategori baik. Koefisien regresi menunjukkan adanya pengaruh keterampilan berpikir kritis terhadap miskonsepsi yang dapat dilihat dari F_ = 28,740 dengan tingkat signifikansi/probabilitas 0,001 < 0,05. Disimpulkan bahwa ada pengaruh keterampilan berpikir kritis terhadap miskonsepsi, dilihat dari semakin tinggi nilai keterampilan berpikir kritis maka semakin rendah siswa yang mengalami miskonsepsi.

ABSTRACT

Misconceptions are errors in connecting concepts that result in understanding new ideas and concepts in students' minds into wrong concepts. This study aims to analyze the effect of critical thinking skills on misconceptions in magnetic field material. The research method used in this study is mixed method. In this study, the sampling technique used was a simple random sampling technique to take the sample from the population. The sample used was 30 students taken randomly through a lottery, so 30 students were obtained as samples. The data collection instruments used in this study were interview sheets and questionnaires. The research design used was a sequential explanatory design. From the descriptive results of the misconceptions data, it is found that the mean of students' misconceptions is 3.59, which means that students' misconceptions are still relatively low. The descriptive results of critical thinking skills data show that the mean of critical thinking skills is 64.03, which means students' critical thinking skills are in a good category. The regression coefficient indicates an influence of critical thinking skills on misconceptions that can be seen from F_ = 28,740 with a significance/probability level of 0.001 < 0.05. It was concluded that there was an effect of critical thinking skills on misconceptions, seen from the higher the value of critical thinking skills, the lower students experiencing misconceptions.

1. INTRODUCTION

Achievement of the purpose of education, we need a teaching and learning process that can influence students in learning activities (Choirun & Anggana, 2014; Maharani et al., 2019). By achieving these educational goals, teachers as educators have an important role for students in building character and

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behavior both intellectually, morally, and socially, and students can create an active, fun, and memorable teaching and learning atmosphere in learning activities (Sholihat et al., 2017; Widyaningsih et al., 2020). Moreover in the learning physics which aims to make students able to master concepts and their relevance in everyday life. But not all students can understand or master the concept well. This can cause students to experience misconceptions or not understand the concept (Agustina et al., 2021; Saputri & Nurussaniah, 2015). Misconceptions are concepts that deviate from concepts that have been set by experts and are inherent in the students themselves. Misconceptions often occur in physics learning, one of the materials where students often experience misconceptions is the magnetic field material.

In this magnetic field material, some sub-concepts will be studied, including magnetic fields, magnetic forces, and the application of magnetic forces. Each of these sub-concepts must be understood by students both physically and mathematically. Based on the results of research that has been done by previous researchers at SMA Negeri 4 Semarang which stated that 74% of class XII students did not understand the magnetic field material they were studying (Agustina et al., 2021; Setyaningsih et al., 2018). It can be seen from the difficulty of understanding the concept of a magnetic field, where many formulas cause misconceptions in understanding the material (Ariani, 2020; Leasa et al., 2020). The causes of conceptual errors in students can be in the form of preconceptions, unprepared mental structures, and students' ways of thinkinh (Mason, 2007; Wahyudi et al., 2013; Yuliati, 2017). One of the skills students needs to understand magnetic field material is critical thinking skills (Purawati et al., 2016; Rositawati, 2018).

One of the skills that students must have today is critical thinking skills. Critical thinking skill is one of the skills that can analyze and evaluate information that has been obtained from observations, experience, reasoning, and communication to decide whether students can accept the information. In education, critical thinking skills are a top priority to achieve learning objectives (Hasnawati et al., 2021; Purawati et al., 2016; Rini et al., 2020; Spector & Ma, 2019). But if learning does not involve students actively, it can hinder students' critical thinking and problem-solving skills. Thinking skills need to be developed in learning physics, especially magnetic field material, so that students can more easily understand, not just memorize formulas. The teacher can also hone this critical thinking skill by giving questions related to ongoing learning, especially on magnetic field material (N. F. Amelia & Pujiastuti, 2016; Jolley et al., 2020; Rositawati, 2018). For this reason, students' critical thinking skills are needed to reduce the occurrence of misconceptions.

Misconceptions are errors in connecting concepts that result in understanding new ideas and concepts in students' minds into wrong concepts (Lemmer et al., 2020; Nurulwati et al., 2014). Several factors cause misconceptions in learning, including understanding the wrong initial concept, students' ability to understand questions, using wrong terms in everyday education, and lack of student interest in understanding the concepts being taught (Dwi et al., 2013; Mubarak & Yahdi, 2020). A learning process that does not pay attention to misconceptions can cause students difficulties in further learning and can impact student achievement. Therefore, the misconceptions experienced by students should be reduced by improving critical thinking skills in problem-solving and involving students to be active in learning (Alhalhinduan et al., 2016; Astuti et al., 2019). Critical thinking skills are one of the thinking processes based on thinking to express opinions or reasons that can conclude and solve problems (S. R. Amelia & Pujiastuti, 2020; Hussin et al., 2019). The teacher can also develop this critical thinking skill. But, in learning activities, students' critical thinking skills have not been fully developed because when the learning process takes place, it is still centered on the teacher, not on the students (Firdaus et al., 2019; Nurrokhmanti et al., 2016). It causes frequent misunderstandings during the learning process because it is still teacher-centered (Missa et al., 2020; Pure, 2013).

Several studies have been carried out previously related to the research to be carried out. The research done by previous research explains the analysis of students' critical thinking skills levels to determine how students' critical thinking skills are at school (Susilawati et al., 2020). Other research has been done by other study on efforts to build critical thinking skills using concept maps to reduce misconceptions of physics (Negoro et al., 2018). Another research was conducted researched improving students' critical thinking skills through involvement in classroom learning. It means that students are more active in asking, searching, finding, and finding solutions in this study (Okolie et al., 2021; Tejedor et al., 2019).

The urgency of this research is to see the effect of critical thinking skills and misconceptions on the magnetic field material. In previous studies, no one has examined the magnetic field material using the fourth level diagnostic test instrument and the effect of critical thinking skills on these misconceptions. Therefore, researchers are interested in doing this research to see students' misconceptions and critical thinking skills. By analyses misconceptions and critical thinking skills, researchers will be able to determine how much influence critical thinking skills have on students' misconceptions, especially on magnetic

material, so this research is essential. This research aims to analyse the results of the assessment of students' misconceptions and know the level of students' critical thinking skills. In addition, the purpose of this study is to analyses critical thinking skills influence the results of students' misconceptions.

2. METHOD

The research method used in this study is mixed. A mixed-method is an approach that combines quantitative and qualitative research (Ashari et al., 2016; Tanti, Darmaji, et al., 2021). The research design used is a sequential explanatory design where this design prioritizes quantitative methods, which will be a source of measurable and detailed data, after which qualitative data is used as an addition to strengthening the results of existing quantitative data (Purba & Simanjuntak, 2011; Sandra et al., 2021; Sujito & Pebriana, 2018). In this study, the sampling technique used was a *simple random sampling technique* to take the sample from the population (Ramadhan et al., 2019; Sugiyono, 2019). The population used in this study was all students in year twelve at SMA Negeri 8 Jambi City. The sample used was 30 students taken randomly through a lottery, so 30 students were obtained as samples.

The data collection instruments used in this study was interview sheets and questionnaires. The questionnaires used are a four-tier format misconception questionnaire on magnetic field material and a critical thinking skills questionnaire. The misconceptions questionnaire consisting of 7 items in a four-tier format on magnetic field material that has passed validation and reliability tests. The indicators contained in the magnetic field material are (1) the force on the charged particles moving in a magnetic field, (2) the magnetic field on a current coiled wire, (3) the magnetic force, (4) the application of the resulting magnet concept, (5) the magnetic field at the tip of the solenoid, (6) the magnetic field at the center of the solenoid, (7) the magnetic field at the toroid. Then the critical thinking skills questionnaire was consists of 20 statement items and is divided into seven indicators. The scale used in the critical thinking skills questionnaire is a Likert scale with five scales. The critical thinking skills questionnaire grid can be seen in Table 1.

Table 1. Critical Thinking Skills Grid

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**

Data collection in this study begins by administering a four-tier misconception questionnaire; then, students filling a critical thinking skill questionnaire so that the data in this study has been obtained (Rahmatih et al., 2020; Tanti, Darmaji, et al., 2021). The research design used was a sequential explanatory design; this design prioritizes quantitative methods, which gained the primary data source. After that, qualitative data was used to strengthen quantitative data (Hidayati et al., 2021; Tanti, Kurniawan, et al., 2021; Wirantasa, 2017). Furthermore, normality and linearity tests were carried out as a condition to test the inferential hypothesis (Iqbal et al., 2022; Soeharto et al., 2019). After that, an inferential analysis performed using ic used is a linear regression test. Then the qualitative data were analyzed using Miles and Huberman analysis, wherein this analysis interview data were collected, then reduced, displayed, and concluded. Furthermore, normality and linearity tests were carried out as a condition to test the inferential hypothesis (Iqbal et al., 2022). This study performed an inferential analysis using a linear regression test. Then qualitative data was analyzed using analysis, where in this analysis interview data were collected, then reduced, displayed, then conclusions were made from the existing data (Miles, M. B., Huberman, A. M., & Saldaña, 2018). The data collection diagram is in accordance with Figure 1.

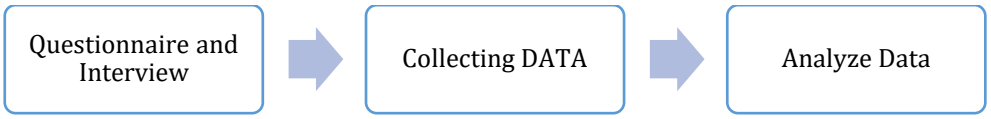

Figure 1. Data Collection Diagram

3. RESULT AND DISCUSSION

Result

After collecting data, then descriptive analysis was carried out on the data of misconceptions and critical thinking skills. The results of the descriptive analysis of the material misconceptions about the Magnetic Field can be seen in Table 2.

Table 2. Descriptive Statistics of the Misconception of the Force Field Material

Statistic	Misconception
Mean	3.59
Median	3.50
Mode	4
Minimum	1
Maximum	7

Based on Table 2, the descriptive statistical results of students' misconceptions on the magnetic field material are obtained where the mean is 3.59, the median is 3.50, the mode is 4, and the minimum maximum value is 7 and 1. The results of descriptive statistical analysis of critical thinking skills data can be seen in Table 3.

Table 3. Descriptive Statistics of Critical Thinking Skills

interval	Category	Mean	Me	Mo	Max	Min
5-24	Very Bad					
25-43	Bad					
44-62	Neutral					
63-81	Good	64.03	61.00	58	90	41
82-100	Very Good					

Based on Table 3, the results of descriptive statistical analysis of students' critical thinking skills are in the form of a mean of 64.03, which falls into the good category, the median result is 61.00, the mode is 58, and the minimum and maximum value are 90 and 41, respectively. The normality of misconceptions and students' critical thinking skills data is in Table 4.

Table 4. Tests of Normality

Variable	Kolmogorov-Smirnova	
	Sig.	Normal Distribution
Magnetic Field Misconception	0.077	Normal
	0.200	Normal

Based on Table 4, the normality test results of misconceptions on the magnetic field material and critical thinking skills are 0.077 and 0.200, which means that the data is normally distributed; the significance value is greater than 0.05. The linearity test results are in Table 5.

Tabel 5. Linearity Test

Statistic				Sum Of Squares	df	Mean Square	F	Sig.
Critical thinking skills* misconceptions	Between Groups	Within Groups	Between Groups	58	21	2.843	6.203	.058
			Between Groups	58	1	32.097	70,029	

Statistic		Sum Of Squares	df	Mean Square	F	Sig.
	Between Groups	58 3,667	20 58	1,380	3.011 0.000	0.094
Total		**63,367**	**58**			

Based on Table 5, it can be seen that the linearity significance value of critical thinking skills and students' misconceptions is 0.094, which means that the data is linear and fulfill the requirements for the linearity test, which must be greater than 0.05 (Rahmatih et al., 2020). The regression test results to see the effect of critical thinking skills on students' misconceptions can are in Table 6.

Table 6. The results of the Critical Thinking Skills Regression Test on the Misconceptions of Magnetic Field Material

Mode I	R	R square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sing. F Change
1	0.712	0.507	0.489	9.176	0.507	28,740	1	28	0.000

From the results in Table 6, the regression value or influence test is obtained, where the R square value is 0.507 and Sig. F changes 0.000, which indicates an influence of critical thinking skills on the misconception of magnetic fields by 50%. The results of the ANOVA test can are in Table 7.

Table. 7 Results of the Anova test for Critical Thinking Skills on the Misconceptions of Magnetic field Material

Model		Sum Of Squares	df	Mean Square	F	Sig.
1	Regression Residual	2419,639 2357,328	1 28	1 28	28,740	0.001
Total		**4776,967**	**29**			

Based on Table 7**.** ANOVA results on the misconception of magnetic field material on critical thinking skills can be seen F = 28,740 with a significance level of 0.001.

Table 8. The Results of the Misconception of Force and Field Material Misconceptions on Critical Thinking Skills

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	36,638	5.378		6.813	0.000
	misconception	6.179	1.153	0.712	5.361	0.000

Based on Table 8 the regression equation can be obtained using the general equation Y=a+bX, where Y is the influencing constant variable. With the obtained power Y = 36,638 .+ 6.179X.

Discussion

Based on interviews that have been conducted, the results show that students' critical thinking skills are still quite good, with some students having very good critical thinking skills. The misconceptions among students are still relatively low. Some students still experience misconceptions due to a lack of critical thinking skills. Theoretically, critical thinking skills can be increased, but students do not have a solid effort to understand the concepts of the material being studied.

From the descriptive results of the misconceptions data, it is found that the mean of students' misconceptions is 3.59, which means that students' misconceptions are still relatively low. The median obtained is 3.50, which shows that the distribution of the data indicates that there are not too many students who experience misconceptions with this median. The mode obtained is 4, which shows that most students have misconceptions of 4 questions. The minimum data result received 1, where the scatter of data shows the smallest. The maximum data result obtained 7, where the maximum data result from any data is large.

From the descriptive results of critical thinking skills data, it is found that the mean of critical thinking skills is 64.03, which means students' critical thinking skills are in a good category. The median is 61.00, which shows the data distribution, which means that many students have critical thinking skills. The mode is 58, which shows that most students experience good critical thinking skills. The minimum data obtained is 41, where the minimum data shows the smallest data distribution. The maximum data obtained is 90, which shows the largest data distribution.

The regression coefficients' results show that there is an influence between critical thinking skills and misconceptions, which can be seen from F_count = 28.740 with a significance/probability level of 0.001 <0.05. If the probability > 0.05, Ho is accepted, and Ha is rejected (not significant). But if the probability is < 0.05, then Ho is rejected, and Ha is accepted, which means the probability number obtained is significant (Ernst & Monroe, 2007; Kizilcik et al., 2015; Turkmen & USTA, 2016). Thus, it turns out that there is an influence between critical thinking skills and misconceptions of 50%, which can be seen on the R Square of 0.507. It can be seen if misconceptions are high, critical thinking skills are low; on the contrary, if critical thinking skills are low, then the misconceptions experienced by students are high. Critical thinking can make it easier for students to express opinions from others and not easily believe them. When students know that the person's perception is wrong, they will help them find the truth. It, of course, will minimize misperceptions. Critical thinking skills can also help students understand their abilities better and find ways to improve them. When critical thinking skills are high, students understand and can analyze the questions or problems given. Therefore, students need critical thinking to check the truth of information, decide whether the information is acceptable, and answer the questions given by the educator.

The GAP in this study explained the identification of misconceptions and the level of understanding of students on dynamic electricity material where students were tested using misconceptions in the tree-tier test format (Mahdalena & Daulay, 2020; Susilawati et al., 2020). Research conducted by previous study explained the identification of misconceptions in the material of electric potential using a three-tier diagnostic test instrument which was carried out using the help of the google form media (Maison et al., 2020; Maryam, 2020). Other research conducted by previous research explains the identification of misconceptions by using a three-tier multiple-choice diagnostic test for movement and style material (Safriana & Irfan, 2021). A study conducted by other study showed the misconceptions that occur in science learning using diagnostic tests to identify students' misconceptions in science (Soeharto et al., 2019). Other research that has been done by previous researched efforts to build critical thinking skills using concept maps to reduce misconceptions of physics (Negoro et al., 2018; Sholihat et al., 2017).

Novelty in this research is to see the effect of critical thinking skills on students' misconceptions of magnetic field material. Where significant influence between critical thinking skills and misconceptions on magnetic field material, we can see if students' critical thinking skills are high, it will be less likely for students to experience misconceptions. But if students' critical thinking skills are low, the chances of misconceptions are high.

Misconceptions can be caused by many things, one of which is the ability to think critically. Therefore, increasing students' critical thinking skills about magnetic field material will reduce their misconceptions. The limitation is that first, it only identifies misconceptions using a four-tier instrument. Second, the material contained in this study is only a magnetic field contained in the magnetic subsection. Third, this study looks at the effect of critical thinking skills on misconceptions. We know that physics material in universities is broad, so it is not limited to electric field materials. With this, further research can be done with other physics materials

4. CONCLUSION

It was concluded that there was an effect of critical thinking skills on misconceptions, seen from the higher the value of critical thinking skills, the lower students experiencing misconceptions. This research will give an impact in the form of an illustration that misconceptions can be caused by the level of students' critical thinking skills that this research is essential because it can find out how much critical thinking skills and levels of misconceptions are, especially in electric field learning.

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