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Analysis of the relationship between critical thinking abilities and the learning objectives of Ohm's law for students studying physics in 2022

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ABSTRACT

The ability to logically and rationally analyze, assess, and generate arguments and concepts is known as critical thinking. The dependent variable, also known as the predicted variable, and the independent variable, sometimes known as the predictor, are the two variables that are studied in linear regression analysis. With physics learning outcomes on Ohm's Law content as the dependent variable and critical thinking ability as the independent variable, this study used a quantitative methodology. Statistical data analysis is done with the help of the SPSS (Statistical Program for Social Science) software. The analysis's findings indicate that among 2022 physics education students, critical thinking skills and physics learning outcomes have a major impact on the material on Ohm's Law. The study found a strong correlation between Critical Thinking Ability and Physics Learning Outcomes, with an Rsquare value of 95.3%, with the remaining 4.7% attributed to other factors.

Keywords: SPSS, critical thinking skills, regression analysis

INTRODUCTION

Rapid change and the rapid development of science and technology, which are getting more complex every day, are characteristics of 21st-century human life. To compete in the age of globalization, the rapid advancement of science and technology necessitates the creation of exceptional and high-quality human resources. This has to do with the reality that a country's progress is determined by the caliber of its people resources. The standard of education in that country determines the caliber of human resources[1].

Since education allows people to learn and therefore develop their potential through a systematic learning process in compliance with the relevant government regulations, it is an essential necessity for a nation that embraces all citizens. Furthermore, education contributes to the development of positive attitudes, values, and character in people [2]. Learning physics is important in the educational context. From the motion of things to the characteristics of matter to other natural phenomena, physics is the science that investigates the cosmos and the natural events that take place in the immediate surroundings. Learning physics fosters the development of analytical, critical, and creative thinking abilities in addition to a grasp of the physical world[3].

It is imperative that all learners develop critical thinking skills as a core competency during the learning process. Critical thinking skills are defined as the ability to engage in reflective thinking, which involves cognitive

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processes that guide learners in analyzing problems. These skills encompass a range of mental activities involved in problem-solving, particularly the ability to search for, analyze and evaluate information. A distinguishing feature of critical thinkers is their propensity to seek, analyze, and evaluate information, which subsequently leads to conclusions based on facts, culminating in effective decision-making[5].

Critical thinking is the ability to objectively analyze, evaluate, and structure arguments and concepts in a logical and rational manner. It involves the ability to identify weaknesses in thinking, evaluate the strength of evidence, and develop conclusions based on objective judgment[6]. Critical thinking involves the ability to look at problems from multiple points of view, question assumptions, and use intelligent reasoning to achieve deeper understanding[7]. The importance of critical thinking for students is significant. The following are some key benefits of critical thinking for students: (1) Development of Analytical Skills. (2) Thoughtful Decision Making. (3) Effective Problem Solving. (4) Development of Communication Skills. (5) Appreciation of Diversity. By developing critical thinking skills, students can become active learners, better able to overcome challenges, and gain a deeper understanding of the world around them. Critical thinking skills provide students with a robust foundation to navigate the challenges of academic, professional and everyday life[8].

In statistics, there are various types of data analysis which are divided into two, namely parametric and non-parametric statistics. Parametric statistical analysis is a statistical method that is based on certain assumptions about the distribution of the population being observed. It requires knowledge of population parameters, such as the mean and variance, and assumes that the data being analyzed follows a certain distribution. Here are some commonly used parametric statistical analysis techniques: (1) Parametric Hypothesis Testing: This method involves testing hypotheses about population parameters, such as the t-test for the difference between two means, the F-test for comparing variances, or the chi-square test for testing the goodness of fit of the distribution. Examples of parametric hypothesis testing techniques include the t-test, ANOVA test, linear regression test, and so on. (2) Analysis of Variance (ANOVA): Analysis of variance is a parametric technique used to compare the means of different groups in one or more dependent variables. ANOVA assumes that the data follows a normal distribution and checks whether there are significant differences between the group means. (3) The t-test, developed by William Seely Gosset, is one of the methods in inferential statistical analysis. The t-test, also known as Student's t-test, is used to compare whether there is a significant difference between the means of a population or two populations. The t-test has two procedures based on the number of samples, namely the one-sample t-test and the two-sample t-test. (4) Regression Analysis: Parametric regression analysis is used to model the relationship between one or more independent variables and a dependent variable. Simple and multiple linear regression are common examples of parametric regression analysis. In this analysis, a regression model is developed by assuming a linear relationship between the independent and dependent variables, and the population parameters are estimated using techniques such as the least squares method[9].

Linear regression analysis is used to study the relationship between two variables, namely the dependent variable (the variable to be predicted) and the independent variable (the variable used as a predictor) [10]. In linear

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regression analysis, a regression equation is used to determine the most suitable straight line equation to describe the relationship between the two variables [11]. Linear regression analysis has various applications in various fields of study. One example is studying the relationship between students' critical thinking skills and learning outcomes [12]. With the problems above, this study aims to determine the effect of critical thinking skills on the learning outcomes of physics on Ohm's law material for physical education students in 2022.

RESEARCH METHODS

This study uses a quantitative method with the variable "Critical Thinking Ability" as the independent variable and "Physics Learning Outcomes of Ohm's Law Material" as the dependent variable. In the critical thinking ability variable, there are two indicators that will be tested, namely "Ability to Draw Conclusions" and "Ability to Analyze Components". So there are 2 variables that will be tested for regression against the physics learning outcome variable. The approach used is a descriptive approach by examining a certain population or sample from Physics Education students of the 2022 batch of Jember University.

The data collection method used a questionnaire method distributed to several classes of Physics Education students class of 2022. The questionnaire method was compiled with several questions and alternative answers related to the research variables. Data analysis used SPSS software with 53 students as respondents. SPSS (Statistical Program for Social Science) software is software used to analyze statistical data. The testing steps are as follows:

- Descriptive Analysis

  Descriptive statistical analysis is presented as supporting information to determine the number of N data, range, maximum and minimum values, mean, and standard deviation for each variable.

- Normality Test

  This test is used to determine whether the data distribution is normally distributed or not. The method used for the normality test is Kolmogorov-Smirnov with Exact Monte Carlo. In general, the exact used to perform the normality test is Asymptotic, but this exact has a weakness, "There are many different data configurations where the asymptotic methods perform poorly. These include small data sets, data sets containing ties, large but unbalanced data sets, and sparse data sets" There are many different data configurations where the Asymptotic method performs poorly. These include small data sets, data sets containing ties, large but unbalanced data sets, and sparse data sets [13]. The purpose of using exact Monte Carlo is to determine whether extreme data is normally distributed or not [14].

- Multiple Linear Regression Analysis

  This analysis aims to determine the influence between 2 or more independent variables on the dependent variable.

RESULTS AND DISCUSSION

After obtaining data from the results of the questionnaire that had been distributed to 53 Physics Education students of the 2022 intake at the University of Jember, the results were obtained regarding the required variables.

Table 1. Descriptive statistics

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Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Penarikan kesimpulan	53	11	12	23	19.30	2.358
Menganalisis komponen	53	11	10	21	15.77	2.636
Hasil belajar fisika hukum ohm	53	14	74	88	81.23	2.833
Valid N (listwise)	53					

Table 1 shows descriptive statistics. Descriptive statistical data provides a brief overview of the distribution and characteristics of the observed data. This information can be used to understand the center of the data (mean), the spread of the data (range and standard deviation), and the minimum and maximum values observed in each variable. In the descriptive statistical data above, there are three variables measured in a sample of 53 individuals. In the conclusion drawing variable, it can be observed that the number of data is 53. The data range, which is the difference between the maximum and minimum values, is 11. The minimum value is 12 and the maximum value is 23. The average of this data is 19.30, with a standard deviation of 2,358. in the variable analyzing the components, the number of data is 53. The data range is 11, with a minimum value of 10 and a maximum value of 21. The average of this data is 15.77, with a standard deviation of 2,636. in the variable "Ohm's Law Physics Learning Outcomes" has a total of data of 53 individuals. The range of the data, which is the difference between the maximum and minimum values, is 14. The minimum value of this data is 74 and the maximum value is 88. The average of this data is 81.23, with a standard deviation of 2,833. This shows that in the observed sample, the average value of the physics learning outcomes of Ohm's law is 81.23, with a relatively small variation of 2,833. The range of data that occurs between 74 and 88 shows a relatively narrow variation in learning outcome scores.

Table 2. Normality Test Results

One-Sample Kolmogorov-Smirnov Test

			Penarikan kesimpulan	Menganalisis komponen	Hasil belajar fisika hukum ohm
N			53	53	53
Normal Parameters[a,b]	Mean		19.30	15.77	81.23
	Std. Deviation		2.358	2.636	2.833
Most Extreme Differences	Absolute		.177	.118	.099
	Positive		.162	.118	.099
	Negative		-.177	-.103	-.090
Test Statistic			.177	.118	.099
Asymp. Sig. (2-tailed)			.000[c]	.064[c]	.200[c,e]
Monte Carlo Sig. (2-tailed)	Sig.		.063[d]	.418[d]	.639[d]
	99% Confidence Interval	Lower Bound	.056	.405	.626
		Upper Bound	.069	.430	.651

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.
d. Based on 10000 sampled tables with starting seed 562334227.
e. This is a lower bound of the true significance.

Table 2 shows the results of the Kolmogorov-Smirnov normality test using Exact Monte Carlo. The basis for making the decision of the Kolmogorov-Smirnov normality test is if the significance value is > 0.05 then the data is normally distributed. Conversely, if the significance value is < 0.05 then the data is not normally distributed. In the Monte Carlo Sig. (2-tailed) section, the sig. value is obtained from two sub-components of "Critical Thinking Ability", namely "Ability to Draw Conclusions" with a Sig. value of 0.063 and "Ability to Analyze Components" with a Sig. value of 0.418. Then in "Physics Learning Outcomes" the Sig. value is obtained of 0.639. This indicates that the data from the three variables are normally distributed.

Table 3. Model Summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.976[a]	.953	.952	.623

a. Predictors: (Constant), Menganalisis komponen, Penarikan kesimpulan
b. Dependent Variable: Hasil belajar fisika hukum ohm

In Table 3, the results of the multiple linear regression model are obtained with the dependent variable "Ohm's Law Physics Learning Outcomes" and two independent

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variables, namely "Analyzing Components" and "Drawing Conclusions". In the table, the R value shows the relationship between the dependent variable and the independent variable as a whole. In this case, the R value is 0.976. A value close to 1 indicates a strong relationship between the dependent variable and the independent variable. The R Square value shows how much influence the independent variables simultaneously (together) have on the dependent variable in percentage. In this case, the R Square is 0.953, which means that about 95.3% of the influence in the dependent variable can be explained by the independent variables in the model.

Std. Error of the Estimate is an estimate of the model's prediction error from the standard deviation. The lower the value, the better the model can predict the dependent variable. In this case, the Std. Error of the Estimate value is 0.623. This indicates a low error rate.

Table 4. Anova

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	397.877	2	198.939	512.577	.000[b]
	Residual	19.406	50	.388		
	Total	417.283	52			

a. Dependent Variable: Hasil belajar fisika hukum ohm

b. Predictors: (Constant), Menganalisis komponen, Penarikan kesimpulan

Table 4. Shows the contribution of independent variables simultaneously (together) to the dependent variable. The basis for decision making is if the sig. value < 0.005 then there is a simultaneous contribution of independent variables to the independent variable. If the sig. value > 0.05 then there is no contribution of independent variables to the dependent variable. In table 4, the sig. value is 0.000. This value is smaller than 0.05, which means that there is a simultaneous contribution of independent variables (together) to the dependent variable.

Table 5. Coefficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	54.928	.848		64.767	.000
	Penarikan kesimpulan	.740	.037	.616	20.142	.000
	Menganalisis komponen	.761	.033	.708	23.145	.000

a. Dependent Variable: Hasil belajar fisika hukum ohm

Table 5 shows the results of the regression coefficient estimation for the multiple linear regression model with the dependent variable "Ohm's Law Physics Learning Outcomes" and two dependent variables, namely "Drawing Conclusions" and "Analyzing Components". This table shows the contribution of the independent variables individually to the dependent variable. The basis for decision making is if the sig. value <0.05 then there is a contribution of the independent variables individually to the dependent variable. In table 5 above, the sig. value of the "Drawing Conclusions" variable is 0.000 <0.05. While in the "Analyzing Components" variable, the sig. value is 0.000 <0.05. From these results, it can be said that there is a contribution of the independent variables individually to the dependent variable.

Based on the results of the analysis, it can be seen that there is a significant influence between Critical Thinking Ability on Physics Learning Outcomes in Ohm's Law Material for Physics Education Students in 2022. This is evident from the Rsquare value of 95.3% (between 90% < x < 100%) where this value indicates the strength of the influence between the variable "Critical thinking ability" on "Physics Learning Outcomes" is very strong.

CONCLUSION

Based on the results of the regression model obtained by 95.3% where the value shows the

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significant influence of Critical Thinking Ability on Physics Learning Outcomes of Ohm's Law Material. While the remaining 4.7% can be explained by other factors not examined in this study. From these results it can be said that there is a contribution of independent variables individually to the dependent variable.

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