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The influence of right and left brain intelligence on mathematics learning achievement

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Abstract. This research aims to determine the effects of right and left brain intelligence on mathematics learning achievement. This research used a quantitative approach with ex post facto research type involving learning achievement as the dependent variable and right brain acumen and left brain intelligence as an independent variable. The subjects in this research are seventh-grade students in junior high school in Madiun. The data collection instrument used is the mathematics achievement test and the right and left brain intelligence questionnaire. Data analysis in this research uses simple linear regression. The results of the research showed that there was an influence between the intelligence of the right and left brains on students' mathematics learning achievement. The influence of right brain intelligence is 28%, and left brain intelligence is 46.7%.

1. Introduction

Learning outcomes have gained more attention in the development of the higher education department. The design of learning outcomes has a significant impact on students' satisfaction, motivation, engagement with their studies and achievement of the learning outcomes [1]. One indicator of achieving learning outcomes is learning achievement. The success of a learning process can be seen from the learning student achievement. One of the indicators of the success of mathematics education is learning achievements obtained by students in the field of mathematics studies. The importance of mathematics has been recognized by many research literature. Mathematical education has a strategic role in the context of human resources and globalization [2]. According to [3], a mathematics education based on these ideas can prepare students to participate in extended peer communities. Mathematics should be introduced to students early on because mathematics is important. This is in line with the statement [4] that today there is a broad consensus that early mathematics education is essential to provide children with a broad foundation for their further mathematical learning. With the habit of learning mathematics from an early age will affect the motivation to learn someone. Motivation and achievement are known to be related [5].

In addition to learning motivation, there are many factors that influence students' mathematics learning achievement, as the results of research conducted by Mundia and Metussin [6]. They stated that some aspects of coping mechanisms, studying strategies, learning styles, and self-efficacy was associated with mathematics achievement positively or negatively. In addition, the study also identified several interaction variables that have joint links to mathematics achievement. One of the factors associated with learning achievement is intelligence. According to [7], intelligence is a specific set of skills that includes the abilities to reason, learn, plan and solve problems. Intelligence plays a big role, especially towards high and low learning achievement achieved by students [8]. There are many

studies that aim to see the influence of several types of intelligence on mathematics learning achievement. As for some of the results of the research that has been done shows that there is a significant positive effect of mathematical-logical intelligence on the results of learning mathematics [9], there is a positive influence between emotional intelligence on mathematics learning outcomes [10], there is a direct effect of numerical intelligence on mathematics learning achievement [11], and there is a significant relationship between intelligence with mathematics learning achievement of student [12].

Based on some research results show the influence between intelligence and student achievement. Intelligence is the intellectual activity of the human brain. According to the split-brain theory of Roger Sperry, all intellectual activity of the human brain is processed by parts of the human body called the big brain. The large brain (cerebrum) is the largest part of the human brain. In this theory also stated that the large brain is divided into two, the left brain hemisphere (brain's left hemisphere) and right brain hemisphere (brain's right hemisphere) [13]. Both hemispheres of the brain have different functions and characteristics. According to [14], the left hemisphere tends to process information in the form of words, numbers, logic, analysis, lists and counting abilities. The right brain hemisphere tends to process information in the form of conceptual thinking, color, rhythm, music, visual-spatial, image, and imagination and the ability to generate creative ideas. Research results from Oflaz ([15]) explaining that right-brained students who were good at responding to demonstrating instructions and visuals showed a good performance in the vocabulary part. as being open to open-ended questions they were also good at the writing part. Left-brained students, who were good at problem-solving by logic and who can see the differences, did well in the use of English and reading parts.

The left hemisphere and the right brain hemisphere greatly affect the style of thinking of every human being. Every human being has a different style of thinking. There are people whose thoughts are more influenced by the left hemisphere that is logical, rational, analytic, objective, sequential and specific. There are also people who are more influenced by the right brain hemisphere's more free and random thinking style, more comprehensive, emphasizing intuition, subjective, synthesis and abstract. The difference between one's thinking style is reinforced by the results of the study Sumardi and Hidayat ([16]) which shows a significant difference between the performance of the left brain and the brain in the lectures of students majoring in physical education. Although the anatomical differences between the left and right hemispheres are not so significant, the way they function differs greatly from one another. Control over the body's functions and sensation is divided between the two hemispheres evenly but in a crossed fashion. In other words, the left hemisphere controls the right side of the body and vise versa [17]. The style of thinking of a different person causes the process of receiving information from every human being also different, including in the learning process, especially in terms of Mathematics.

In everyday life, there is a tendency that someone uses the hemisphere more often in the process of receiving information and thinking. This is by experts called brain dominance (brain dominance). Different brain dominance among individuals is a widely accepted and known fact, in which each hemisphere of the brain contributes to certain body functions, each person has the unique ways of perceiving, interpretations and utilization of given information and it may affect the student's achievement [18]. Referring to the characteristics of the right brain and the left brain that have been explained previously, researchers are interested in seeing the influence between left and right brain intelligence on students' mathematics learning achievement.

2. Methods

This research was conducted with a quantitative approach, with ex post facto research types. Ex post facto is a research method where the researcher does not give action to the independent variables [19]. The attachment of the independent variable and the dependent variable occurs naturally. So in this study, the researcher will examine the causal relationship of the independent variables on the dependent variable without the treatment of the researcher.

This study aims to find out the influence of independent variables, namely intelligence of the left brain (X_1) and intelligence of the right brain (X_2) on the dependent variable, namely the learning achievement of mathematics (Y). Where the data in the form of numbers collected will be analyzed using a quantitative data approach.

This research was conducted in Public Middle Schools in Madiun District in 2018. According to [20]population is the overall observation that wants to be studied, while the sample is part of the population observed. The population in this study were junior high school students in Madiun regency totaling 255 students. The sample in this study amounted to 156 students who were determined based on the sample calculation formula. The sampling technique was carried out by cluster random sampling.

2.1. Instrument and Data Collection Techniques

This study uses two types of research instruments, namely brain dominance questionnaire in the form of personality tests that show a person dominating using the right or left brain. The brain domination questionnaire is referenced from [21]. The second instrument is a mathematics learning achievement test. The first learning achievement test was validated by the expert, after being validated the instrument was tested including validity test, reliability test, difficulty level test, and distinguishing test.

The data used in this study is secondary data and primary data. Secondary data is a source that does not directly provide data to data collectors, for example through other people or through data documents needed to complete the analysis of this study [22]. Primary data obtained from direct sources. The researcher distributed questionnaires to the sample respondents. The questionnaire consists of a set of statements related to the right and left brain domination questionnaires.

Data collection techniques used are psychological and documentation scales. Data captured by the psychological scale is a description of the dominance of the right and the left brain, while data collection with documentation aims to obtain data on students' mathematics learning achievement.

2.2. Data Analysis Techniques

Prerequisite Test The analysis carried out in this study is the Normality Test, Linearity Test, Multicollinearity Test, and Heteroscedasticity Test. Prerequisite Test Analysis is carried out before testing the research hypothesis. This study uses descriptive statistical analysis to provide an overview (description) of research data so that the data displayed is easy to understand and informative.

Hypothesis testing in this study was carried out using simple linear regression analysis and multiple linear regression analysis. The level of significance established in this study is 5% (a = 0.05). This research will be analyzed with descriptive statistics because the research conducted is population research (without taking samples). In descriptive statistics can also look for the strength of the relationship between variables through correlation analysis and predictions with regression analysis [23]. Descriptive statistics include; (1) sample size, (2) minimum and maximum values, (3) mean, (4) standard deviation and variance.

3. Results and Discussion

The research data consists of two variables, namely right brain dominance (X_1) and left brain dominance (X_2) on the dependent variable, namely learning achievement in learning mathematics (Y). This section is part of a research report that provides data that has been collected which includes minimum values, maximum values, mean, standard deviation, and variance. The data used is single data. The results of descriptive statistical analysis related to the score of right brain dominance variables are presented in Table 1.

Table 1. Summary of Right Brain Domination Data

Statistics	Statistical Values
Sample Size (N)	72
Minimum Values	45
Maximum Values	64
Mean	56.57
Standard Deviation	4.702
Variance	22.108

From the description of the brain domination questionnaire data shows that students who belong to the right brain domination class are 72 students with a minimum value of 45 and a maximum of 64. The average score obtained is 56.57 with a standard deviation of 4.702 and variance of 22.108. As for the results of descriptive statistical analysis related to right brain dominance, variable scores are presented in Table 2.

Table 2. Summary of Left Brain Domination Data

Statistics	Statistical values
Sample Size (N)	84
Minimum Values	41
Maximum Values	64
Mean	56.32
Standard Deviation	5.629
Variance	31.691

From the description of brain domination questionnaire data shows that students included in the right brain domination group amounted to 84 students with a minimum score of 41 and maximum 64. The average score obtained was 56.32 with a standard deviation of 5.629 and variance 31.691.

Instrument testing was carried out on multiple achievement test instruments. The results obtained after testing the validity with the product moment correlation formula showed that from the 25 questions tested, 20 of them met the criteria for the validity of the questions, that is $r_{xy} > r_{table}$with $r_{table} = r_{(\alpha.20)} = 0.444$.Reliability test uses the *KR*-20 formula, the instrument is said to be reliable if $r_{11} > r_{table}$[24]. The results of the instrument testing of 20 valid test items obtained $r_{11} = 0.8882$, this means that students 'mathematics learning achievement test instruments have very high reliability so that they can be used to retrieve students' mathematics learning achievement data. The questions that have been tested have fulfilled the good difficulty index (*DI*) criteria, that is $0.30 < DI \leq 0.70$, and has a good differentiation criteria (*DC*) which are more than 0.40 ($DC > 0.40$).

After the data is collected, data processing is done by analyzing statistical data using the help of SPSS statistical software. Before the data is analyzed, it is necessary to test the analysis requirements namely normality test, linearity test, and multicollinearity test. The normality test is done to find out whether the data for each *X* corresponding *Y* values are normal or not. In this study, the normality test used the Lielifors test with criteria $L_{count} > L_{table}$ with a significance level 5% and conditions if $L_{count} > L_{table}$ then the data is not normally distributed, otherwise if $L_{count} < L_{table}$ then the data is normally distributed. Linearity test is conducted to determine whether or not there is a linear relationship between each independent variable with the dependent variable. Linearity test analysis uses the F test with criteria if $F_{count} < F_{table}$ with a significance level 5% then the dependent variable with the dependent variable is linear. Multicollinearity test is used to determine whether there is a high correlation between independent variables. A good regression model requires no multicollinearity problems. Multicollinearity test can be determined by product moment correlation with criteria if the correlation coefficient is less than 0.8, so there is no multicollinearity. Hypothesis testing in this study

uses simple regression analysis techniques to test the first and second hypotheses that have been formulated.

3.1. Right Brain Domination Influence on Mathematics Learning Achievement

Based on the results of simple regression analysis (X_1Y), it was found that the X_1 product-moment correlation coefficient on Y, r_{x_1y} as big as 0.530. The correlation coefficient is positive so it shows that the dominance of the right brain has a positive correlation or relationship to mathematics learning achievement. At the coefficient of determination $r^2_{x_1y}$ as big as 0.80 which means the dominance of the right brain can affect students' mathematics learning achievement by 28%. This shows that in addition to the dominance of the right brain there are still 72% of other factors that can affect the learning achievement of mathematics.

Based on the results of the t-test obtained that the significance value t is equal to 0.000 ($p < 0.05$) so that the hypothesis is accepted which means that there is a positive and significant influence between right brain domination on student learning achievement. Furthermore, the magnitude of the constant is 8.744 and the size of the right brain dominance coefficient (X_1) is 1.027, the regression equation can be stated as follows: Y=8.744+1.027X_1. The coefficient of X_1 from the equation is 1.027 indicating that if the dominance of the right brain (X_1) increases by 1 point, the learning achievement increases by 1.027.

There is a positive influence between the dominance of the right brain on students' mathematics learning achievement in line with the results of the study Sarrasin et. al. ([25]) which shows that inducing a growth mindset by teaching neuroplasticity has an overall positive effect on motivation, achievement, and brain activity. The results also reveal that this intervention seems more beneficial for at-risk students, especially regarding mathematics achievement.

3.2. Left Brain Domination Influence on Mathematics Learning Achievement

Based on the results of a simple regression analysis (X_2Y), it was found that the X_2 product-moment correlation coefficient on Y, r_{x_2y} as big as 0.684. The correlation coefficient is positive so it shows that the ability of left brain domination has a positive correlation or relationship to learning achievement. At the coefficient of determination $r^2_{x_1y}$ as big as 0.467 which means the dominance of the left brain can affect students' mathematics learning achievement by 46.7%. This shows that in addition to the dominance of the left brain there are still 53.3% of other factors that can affect the learning achievement of mathematics.

Based on the results of the t-test obtained that the significance value t is equal to 0.000 ($p < 0.05$), so that the hypothesis is accepted which means that there is a positive and significant influence between the dominance of the left brain on student achievement. Furthermore, the number of constants is 2.813 and the size of the left-brain dominance coefficient (X_2) is 1.215, so the regression equation can be stated as follows: Y= 2.813+1.215X_2. The coefficient of X_2 of the equation is 1.215 indicating that if the mathematical communication ability (X_2) increases by 1 point then the learning achievement of mathematics increases by 1.215.

Influence of the dominance of the left brain (46.7%) is greater than the dominance of the right brain (28%) against student mathematics learning achievement, this can be caused by the characteristics of the left brain which tend to process information in the form of words, numbers, logic, analysis, lists and counting abilities, while the right brain tends to process information in conceptual thought, color, rhythm, music, visual-spatial, image, and imagination and ability to generate creative ideas (the split-brain theory of Roger Sperry) [13]. This is in line with the results of research from [26] that intelligence showed a stronger association with science than with art.

4. Conclusion

From the results of the research that has been done, the researcher can draw conclusions that there is an influence between the dominance of the right and left brain towards students' mathematics learning achievement. Where the large contribution of the influence of right brain dominance is 28%, and left

brain domination is 46.7%. The findings from the study [27] also show significant differences between the learners with different brain dominant in their use of compensation strategies. Considering these differences and their effects on the learning process, the teacher is advised to be able to create a learning process that can accommodate students with the dominance of the left and right brains so that they can understand instruction and material in a balanced manner.

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