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Discovery Learning with Link Map and Motivation on Calculus

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Abstract. Calculus has a high abstractness so calculus requires the ability to think in solving mathematical problems. Calculus is one of the fields of mathematics that is full of calculations and formulas, so it needs the motivation to be happy and interested in calculus. This study aims to analyze discovery learning with link maps and learning motivation on calculus. This research is quantitative descriptive with research variables including discovery learning, link maps and academic abilities of students. The study is conducted at Universitas Kanjuruhan Malang with 105 students. The research data is obtained from the results of the students' academic ability test, the results of student worksheets on discovery learning and link maps and learning motivation with questionnaires. Data analysis uses multiple linear regressions assisted by SPSS. The results show that discovery learning with link maps has a positive effect on students' academic abilities. In addition, motivation influences on discovery learning with link maps and student academic abilities. If students have high motivation and the ability to find their own concepts, the results of the concept last a long time in students' memory, the students' thinking ability and memory of students in understanding mathematical concepts, therefore it can solve mathematics problems better. Discovery learning with link maps gives students better academic abilities.

Keyword: discovery learning; link map; motivation; calculus

1. Introduction

Calculus is one of the fields of science in mathematics. Mathematics is an abstract science. Calculus has high abstractness so calculus requires the ability to think in solving mathematical problems. Calculus requires students not only to answer by memorizing formulas but must be able to answer by conveying the reasons and prove it so that they are able to solve mathematical problems correctly and precisely.

The reality shows that many students experience difficulties in calculus, which affects the academic ability of students with score that is still below the standard of passing a course that is 75. Students are still passive and tend to be quiet when learning. In addition, students lack motivation in learning calculus, so they feel bored and lazy to solve calculus problems. Students' learning motivation is needed in solving mathematical problems. Some factors that influence students' academic abilities, including external factors outside students and internal factors within students. The use of learning methods and

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models are factors that influences the achievement of students' academic abilities, but there is one that plays an important role in achieving students' academic abilities, that is having learning motivation. In this regard, it can be said that the ability to answer calculus problems is closely related to calculus learning that takes place during lectures. Calculus learning must be student-centered so students are actively involved in learning. Some experts argue related to learning mathematics [1][2][3] which states that a learning approach that allows students to be more active in achieving knowledge and developing thinking through presenting problems with relevant contexts. One of the efforts to improve the quality of mathematics learning, especially calculus learning is through discovery learning with link maps and learning motivation.

Discovery learning is an active learning method by finding out by yourself and the results obtained are long lasting in memory and not easily forgotten. discovery Learning has a basic strategy pattern that can be classified into four learning strategies, namely determining the problem, formulating hypotheses, collecting and processing data, and formulating the conclusions [4][5]. Discovery learning is understanding concepts, meanings, and relationships, through an intuitive process and finally come to a conclusion [6][7]. Discovery learning is learning that trains students to play an active role and think in solving mathematical problems. As a support for discovery learning, efforts are needed to improve students' thinking ability, namely link map learning model.

Link map is a learning that trains thinking power through the interrelation of concepts. Students who have an aversion in recording concepts then the students' ideas that emerge in the students' thinking can be expressed in the concept associations that are understood effectively by using a link map. [8][9] states that link maps are learning with complex material that can be delivered into a related map that is easy to process and constructed in students' thinking. [10] states that teachers need to reflect on their practice in order to apply these ideas to their work and that constructivist teachers encourage students to constantly assess how the activity is helping them gain understanding.

In addition, learning motivations is students' learning encouragement to give behavioral changes within themselves and achieving students' academic abilities. [11][12] states that the importance of motivation in learning has been widely recognized and motivation is considered as a complex concept, closely aligned with 'the will to learn', and encompassing self-esteem, self-efficacy, effort, self-regulation, locus of control and goal orientation.

Relevant research as a support in the explanation above, including the results of [13] shows that discovery learning is very useful for students who have high abilities and can also improve their ability for those who are in the medium category. [14] show that effectiveness and efficiency of discovery learning in simulation environments together with problems that learners may encounter in discovery learning, and combined with instructional support in order to overcome these problems. The results of the study [15] shows that the students tended to link from superordinate concepts to subordinate concepts. They seemed to hold different ideas about the relations among the concepts since there were more weak links than moderate and strong links in the collective map. The results of the study [9] conclude that students have the ability to think in understanding the concept of learning with link maps in mathematics. In addition, the results of the study [16] show that discovery and mind map learning can improve mathematical reasoning ability, by involving students and constructing mathematical knowledge of students. Based on phenomena and relevant research results, this study aims to analyze the effect of discovery learning with link maps and learning motivation on students' academic abilities.

2. Research method

This research is quantitative descriptive, with the aim to analyze the effect of discovery learning with link maps on students' academic abilities. Independent variables in this research are discovery learning, link maps and learning motivation, while the dependent variable is student academic ability. The research is carried out in Mathematics Education Study Program, University of Kanjuruhan Malang. The research sample is mathematics education students who have taken calculus the total number is 105 students.

The research instrument is validated by mathematics education lecturers and tested for validity and reliability with SPSS assistance. The research data is obtained from the results of the students' academic ability test, the results of student worksheets on discovery learning and link maps and learning learning motivation with questionnaire. Data analysis use multiple linear regression analysis with SPSS assisted with analysis prerequisite test, hypotheses test and draw conclusions. The analysis prerequisite test includes: normality, multicollinearity, autocorrelation and heteroscedasticity. Hypothesis testing with multiple linear regression.

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3. Results and Discussion

The results of the SPSS-assisted analysis prerequisite test research are: (1) Multicollinearity, shows that the output tolerance of both variables is more than 0,10 in discovery learning by 0,992, link map is 0.998 and the learning motivation is 0,985. Output inflation factor (VIF) of both variables are less than 10 in discovery learning is 1,008, link map is 1,002 and learning motivation is 1,015 so there is no multicollinearity; (2) Autocorrelation, with the Durbin-Watson test shows that the output model summary of 1,624 is in the area without autocorrelation so that autocorrelation does not occur; (3) Heteroscedasticity, by testing the Spearman correlation rho's test also by looking at the pattern of the dots on the scatterplot graph which shows that the distribution of dots does not form a particular pattern / plot and the points spread so that heteroscedasticity does not occur; (4) Normality, using the Normal P-P graph Plot which shows that the dots are not located more or less in a straight line, so it can be concluded that the residual data is normally distributed. The results of the analysis prerequisite test that has been presented show that discovery learning, link maps and learning motivation are stated to have fulfilled the prerequisites of multiple linear regression and instruments can be used for data collection in research. The results with the following table:

Table 1. Descriptive Research Results Table

		Discovery Learning	Link Map	learning motivation	students' academic abilities
N	Valid 14 Missing	105	105	105	105
		0	0	0	0
Mean		28.1238	24.4571	27.1333	75.0095
Std. Error of Mean		.37958	.42258	.39458	.39328
Median		28.0000	24.0000	28.0000	75.0000
Mode		31.00	26.00	28.00 ^a	76.00
Std. Deviation		3.88957	4.33019	4.04320	4.02992
Variance		15.129	18.751	16.347	16.240
Skewness		.235	.284	.260	1.298
Std. Error of Skewness		.236	.236	.236	.236
Kurtosis		.330	.380	.398	6.414
Std. Error of Kurtosis		.467	.467	.467	.467
Range		19.00	19.00	22.00	30.00
Minimum		19.00	16.00	15.00	55.00
Maximum		38.00	35.00	37.00	85.00
Sum		2953.00	2568.00	2849.00	7876.00
Percentiles	25	25.0000	21.0000	25.0000	75.0000
	50	28.0000	24.0000	28.0000	75.0000
	75	31.0000	27.0000	29.5000	76.0000

^aMultiple modes exist. The smallest value is shown

The hypothesis test results with SPSS-assisted linear regression output with the following table:

Table 2. Anova

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1136.196	3	378.732	11.170	.000
	Residual	1678.884	101	33.907		
	Total	1688.990	104			

^a Predictors: (Constant), discovery learning, link map and learning motivation

^b Dependent Variable: students' academic abilities

Table 3. Coefficient Table

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error				Beta	Zero-order	Partial	Part	Tolerance
(Constant)	77.505	4.264		18.175	.000					
Discovery Learning	.542	.103	.140	.405	.043	.044	.040	.040	.992	1.008
Link Map	.560	.093	.017	.168	.037	.009	.017	.017	.988	1.012
Learning motivation	.663	.100	.063	.630	.034	.064	.063	.063	.985	1.015

^a Dependent Variable: students' academic abilities

Table 3. Summary Table

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				Durbin-Watson	
1					R Square Change	F Change	df1	df2	Sig. F Change	
1	.862	.744	.736	4.612	.744	92.894	3	101	.894	1.624

In table I, descriptive research results from discovery learning, link map, learning motivation and students' academic abilities. In table II, the anova table with F test, anova output is simultaneous regression test to test the significance of how much the influence of discovery learning, link maps and learning variables on students' academic abilities with a significance level of 0,05. The result is the F count value of 11,170 with a significant 0,000 and (0,000 < 0,05) means that there is a significant effect between discovery learning, link map and learning on students' academic abilities.

In table III, the coefficient table with multiple linear regression equations, the output coefficients show that the multiple linear regression equation model for the effect of discovery learning, link map, learning on students' academic abilities is: $y = 77,505 + 0,542x_1 + 0,560x_2 + 0,663x_3$. In addition, table II

coefficient table results also show in t test that output of partial regression on discovery learning variables have a significant effect on students' academic ability of 0,542 or 54,2% with significance of 0,043, while the link map variable affects the academic ability of students by 0,560 or 56% with significance of 0,037 and the learning variables on students' academic abilities by 0,663 or 66,3% with significance of 0,035. In table IV, the summary table, with R Square of 0,744 which shows that there is an effect of discovery learning, link maps and learning motivation on students' academic abilities of 74.4%.

The result of students' academic ability test with 105 students. The research of students' academic ability test is obtained from the results of low with 1%, fair with 11,5%, high with 72,3% and very high with 15,2%. The test results of students' academic abilities show that 15,2% of students have the ability to solve calculus problems with discovery learning and map link. Students who initially have less optimal abilities experience changes in understanding the concept of calculus better so that the achievement of students' academic abilities is better and more satisfying.

The benefits of discovery learning include growing curiosity and confidence in solving calculus problems. Link map is useful to help students' memory of mathematical concepts. Learning motivation gets positive responses from students. In accordance with the opinion of [17][18] which state that discovery learning, less in explaining so that students are more active in cognitive learning and encourage learning and motivation and [19] that student motivation and use of learning strategies are related. The academic ability test results of students increase in achievement so that it can be said discovery learning with link map affect the academic ability of students, according to the opinion [8] that thinking ability and more actively in learning with link maps

21 4. Conclusion

On the basis of the results of the research and discussion in this research, it can be concluded that discovery learning with link map affects the achievement of students' academic abilities. If students have the ability to find their own concepts, the results of the concept last a long time in students' memory, the students' thinking ability and memory of students in understanding mathematical concepts, therefore it can solve mathematics problems better. Discovery learning affects the achievement of students' academic abilities. Link map influences achievement of students' academic learning abilities and link map fosters curiosity and confidence in solving mathematical problems. Learning by using discovery learning with link maps fosters students' thinking and memory skills in understanding mathematical concepts. Each figure should have a brief caption describing it and, if necessary, a key to interpret the various lines and symbols on the figure.

5. Acknowledgement

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